NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 7, 1895.

THE GAY SCIENCE OF ARITHMETIC.

L'Arithmétique Amusante. Par Édouard Lucas. Pp. i.–viii. 1–266. (Paris: Gauthier-Villars et Fils, 1895.)

Traité d'Aritmétique. Par C.-A. Laisant et E. Lemoine. Pp. i.–viii. 1–174. (Paris: Gauthier-Villars et Fils, 1895.)

BY the premature death of Édouard Lucas the world lost at once a wit, a scholar, and an original mathematician. This somewhat rare combination of qualities is evident in all his work, and especially in the inimitable "Récréations Mathématiques," which, to those who are able to appreciate it, will always be one of the most entertaining of books. The interest of the problems themselves, the lucidity with which they are discussed, and the brilliant appropriateness of the author's dedications and mottoes, combine to invest the work with a charm peculiarly its own.

It will be remembered that, shortly after Lucas's death, a commission was appointed by the Mathematical Society of France, consisting of the President of the Society for the time being and MM. Delannoy, Laisant and Lemoine, for the purpose of examining and classifying the unpublished manuscripts of the deceased mathematician. Two additional volumes of the "Récréations" were found practically ready for press, and these were published by the commission in 1893 and 1894 respectively. Although they unavoidably suffer to some extent from the lack of the author's final revision (for instance, we miss the usual witty dedication in some cases), these additional volumes are well worthy to rank with their predecessors.

The first of the books now under review is edited by the same commission, and is uniform in size and style with the "Récréations." It is, indeed, described on the title-page (presumably by the editors) as an introduction to the former work; but this, though true in a sense, is rather misleading. It appears from the editors' preface that, so long ago as 1885, Lucas had in preparation a book to be called "l'Arithmétique amusante," and three manuscript note-books bearing this title were found among his papers. The book now published, or rather the first part of it (pp. 1–186), contains the text of these note-books; the remainder consists of a series of four notes, which form a kind of supplement to the "Récréations," and complete the publication of all that Lucas has left relating to this subject.

By far the greater portion of the first part of the book has already appeared, nearly verbatim, in the "Récreations"; the rest consists partly of arithmetical curiosities, such as

$$8 \times 123456789 + 9 = 987654321,$$

and partly of well-known tricks and puzzles, some of which are not even arithmetical; as, for instance, how to convert a 3 into a 5 by a single stroke of the pen. This may be amusing, but is not arithmetic.

Mathematicians in search of novelty will turn with more interest to the notes which fill up the remainder of the volume. Note i. is the text of an address delivered by Lucas on August 4, 1885, at the prize-day of the Lycée Saint-Louis. Note ii. contains two interesting modifications of the problem of the jealous husbands and their wives. Note iii. gives a brief account of the scientific games invented by Lucas. Note iv., which is the most important, comprises different fragments relating to the "Récréations." These are six in number, and deal with the problem of the eight queens, games with ribbons, magic squares and cubes, and the knight's tour. The last problem, in particular, is discussed at some length.

It will be seen from what has been said that the appearance of this book adds little to Lucas's reputation, although, of course, it does nothing to diminish it. In preparing it for publication, the editors have performed a pious duty, for which they deserve our grateful acknowledgments; and the work is likely to appeal successfully to two classes of readers. The happy possessors of the "Récréations" will not rest until they have procured this supplementary volume for the sake of the notes, or for the æsthetic purpose of completing their set; while those who are not so fortunate will be able to make the acquaintance of the author in a comparatively easy and inexpensive way. It is only fair to warn them that, in all probability, they will feel constrained to buy the larger work afterwards.

The treatise of MM. Laisant and Lemoine is intended to serve a double purpose: to provide a strictly scientific introduction to the science of arithmetic, and to exemplify a system of orthography which has been adopted by the "Société filologique française." This is not the place to discuss the system of spelling which is advocated: suffice it to say that it is one of those compromising systems which, while rebelling against tradition, stop short, by a long way, of a strictly phonetic orthography. The consequence is a mass of inconsistency which has not even the excuse of a historical development: thus, for instance, "philosophie" becomes "filosofie," while "science" retains its traditional form. Again, "commun" is changed into "comun," while "irréductible" is left alone.

From a mathematical point of view, the book, as might be expected from the reputation of its authors, is very interesting and valuable. A treatise on elementary arithmetic may be criticised in two different ways, according as it is estimated in relation to pure science or to pedagogy. Most text-books on arithmetic are utterly unscientific, and a treatise like this, which aims at a rigorous method and, on the whole, achieves it, is a welcome acquisition.

The book deals with the four fundamental operations as applied to whole numbers and fractions; the metric system; elementary theory of numbers (prime factors, G.C.M. and L.C.M., recurring decimals, &c.); incommensurables, squares and square roots; ratio and proportion. Most of it is quite admirable; and the criticisms which follow are offered in no captious spirit, but as a kind of acknowledgment of the really scientific character of the book.

The authors begin by defining addition as an operation which is independent of the order of the things added; or rather they refrain from giving a definition of addition, and state that any definition must be subject to the condition above stated. Now in arithmetic it is not things, but numbers, that are added, and it is quite possible to give a satisfactory definition of an arithmetical sum. Thus take two groups of objects (in the most abstract sense), count the first group, then the second, and thirdly count the first group as before, but *go on counting* as you pass on to the second group instead of beginning again. Three numbers are thus obtained, and the third is defined to be the result of adding the second to the first. The commutative law follows easily enough.

The authors' definition of a sum is equally applicable to the addition of vectors, and this fact vitiates their statement that "a quantity A is said to be greater than another quantity B when A results from the addition of a quantity C to B."

The objection that concrete "quantities" are introduced, whereas pure arithmetic is concerned with numbers, and numbers only, applies to other parts of the book, notably to the chapter on fractions. It is quite true that concrete illustrations, such as those afforded by a two-foot rule, are very useful, and indeed indispensable for the purposes of primary instruction in the subject, but the *theory* of fractions is independent of these applications. This may be seen, for instance, in Biermann's "Theorie der analytischen Functionen" (after Weierstrass); and it is not difficult to see in Euclid's arithmetical books some foreshadowing of this way of looking at the matter.

Then, again, the treatment of irrational numbers, although greatly superior to that usually found in text-books, does not seem wholly satisfactory. The authors evidently intend to adopt the method of Dedekind, or rather, perhaps, that of Heine, but the way in which this is presented is not very clear. According to Dedekind, the existence of a single definite irrational or transcendental number is established when we are able to define a "Schnitt" in the (discrete) multiplicity of rational numbers; that is to say, when we are able to find a criterion which separates *all* rational numbers into two groups, A and B, such that every number, say a, which belongs to A, is greater than every number b which belongs to B. Thus, for instance, if we assign a rational number to A when its square exceeds 2, and to B when its square is less than 2, we establish a "Schnitt" which defines the irrational number $\sqrt{2}$. Heine's method is not very different from Dedekind's; thus his way of defining $\sqrt{2}$ consists in selecting from the groups A and B, as above defined, two sets of rational numbers:—

$$\begin{array}{llll} a_1, & a_2, & a_3 \cdot & a_n \ldots \\ b_1, & b_2, & b_3 \cdot & b_n \ldots \end{array}$$

such that

$$a_1 > a_2 > a_3 > \ldots > a_n > \ldots \quad (a_n^2 > 2)$$
$$b_1 < b_2 < b_3 < \ldots < b_n < \ldots \quad b_n^2 < 2)$$

and then showing that if n, m are taken large enough, $a_n - b_m$ can be made as small as we please. MM. Laisant and Lemoine, after introducing the problem of measuring an incommensurable quantity, proceed: 'Jusqu'à présent on n'a rien trouvé de mieus pour remplir ce but que d'indiquer tous les nombres entiers ou fractionaires mesurant les quantités plus grandes et les quantités plus petites que A." Now, even if we waive the objection already brought forward, that the measurement of *quantities* is independent of pure arithmetic, and that the assumption that every quantity admits of arithmetical measurement in terms of an arbitrary unit requires justification (and this can only be given *after* the theory of irrational numbers has been established, if indeed then), the above statement is not satisfactory; because if A is really a concrete quantity, the "nombres entiers ou fractionaires," &c., can only mean "quantities commensurable with an assumed unit," and it remains to be proved that the choice of a unit has no influence on the result; while if A is a number, no criterion is given by which we can decide whether a given rational number is greater or less than A. On this point we cannot do better than refer to the preface to Dedekind's invaluable tract, "Was sind und was sollen die Zahlen?" in which the author expressly rejects all theories of irrational numbers based on the assumption of measurable quantities. That he is right in so doing must be admitted by all who reflect on the subject with sufficient attention.

These observations, as already remarked, are not intended to detract from the undoubted merit of the book. Arithmetic is a thorny subject, the very elements of which abound in points of great difficulty and delicacy; and any serious work on the science is certain to contain passages giving occasion for criticism or controversy. MM. Laisant and Lemoine deserve our gratitude for having

written an original and stimulating book, which should be studied, not only by professed mathematicians, but by intelligent school teachers. Such a work ought to do much towards replacing the soul-destroying routine of ordinary school arithmetic by something of a really educative character.

In conclusion, we would ask the reader to turn to the chapter on the metric system, which contains in the compass of about a dozen pages all the "commercial arithmetic" which a French schoolboy has to learn. It seems impossible that any one, after reading this chapter, can refrain from asking himself how it is that the English nation persists in refusing to adopt a system which is as easy to learn as it is convenient to use, and which, as the experience of France has sufficiently shown, could be prescribed by the State without the risk of any, save the most transient, disturbance of trade or exchange. But we are a practical people, and the metric system was invented by "theoreticians"; therefore, we suppose, nails and perches and pennyweights will be with us to the end of time. G. B. M.

THE STRUCTURE AND LIFE OF BIRDS.

The Structure and Life of Birds. By F. W. Headley, M.A., F.Z.S., Assistant Master at Haileybury College. 8vo. Pp. xx. + 412, with seventy-eight illustrations. (London: Macmillan and Co., 1895.)

THE author in his preface intimates that "the aim of this book is an ambitious one," namely, "to give good evidence of the development of birds from reptilian ancestors. . . . and [among other subjects] to make clear the main principles of their noble accomplishment, flight." To the former of these aims Mr. Headley devotes his first five chapters, comparing the differences and resemblances observable in the skeleton and the internal structure of birds and reptiles, and the "ancestral peculiarities" that, having "survived all change of habit," mark their relationship. He then discusses the processes of life that go on within the bird, and make it so different from its lethargic reptilian ancestors, giving a description of the anatomical structure and physiological action of its chief organs. The following paragraph, from the description of the heart and circulation, will exemplify Mr. Headley's style and method of exposition:—

"The heart is a force-pump, which drives the blood to all parts of the body, and when it returns impure and loaded with used-up material, sends it to the lungs to be purified, after which it is despatched all over the body again. On the voyage much of it passes through the kidneys, which help the lungs to purge it of the waste of the tissues. The essentials of an efficient heart are that it should be strong, and that it should keep the pure blood separate from the impure. These two essentials are found combined in the hearts of mammals and birds. They are strong muscles; that part at least of them which forces the blood through the arteries is remarkable for its strong thick walls. And, thanks to the perfection of the machinery, the blood which has been purified in the lungs is never mixed with the impure blood which is coming from the body. The heart is divided into right and left chambers by a division through which there are no doorways. The right and left chambers are each divided into two, but there are openings from the upper into the lower, which may be closed by valves. The two lower chambers are called ventricles, and the two upper ones auricles."

A long chapter is next given to flight, one of the main subjects of the book; the machinery by which flight is accomplished, and the principles underlying the action of its complicated mechanism, with the extraneous aids the bird avails itself of to effect that purpose. Towards a solution of this difficult subject, on which, as the author remarks, "however much is learnt, a great deal more remains to be learned," he has contributed some original observations and experiments, for which we refer the reader to the book itself. A condensed but clear account of the bird's embryology and its subsequent life-history occupies several succeeding chapters. After this the book deals principally with colour and song, instinct and reason, migration and the principles of classification.

There is one statement made by the author, in speaking of the pneumaticity of the bird's bones, to which we feel inclined to take exception. Mr. Headley says on p. 107: "The hornbills, which according to good observers are very poor flyers, are as pneumatic [as to their bones] as any birds, or, perhaps, more so." The present writer's experience of hornbills in their native state extends to many species of several genera, among them the largest and heaviest of them all, the great solid-headed *Buceros galeatus*. Many of these birds, which may be seen—and the rush of their expansive wings can be heard long before that—constantly travelling at a great speed high over the tall virgin forests, and be watched by eye and ear for miles after they have passed over the observer, can scarcely, in his estimation, be accurately designated "poor flyers." They may not take such extended flights as birds on migration do, but they make journeys of considerable length; while in the tops of the highest trees, in quest of their food, they are quite as active and nimbly expert as those excellent flyers, the pigeons, which share with them their raids on the giant Urostigmas.

The volume before us presents little to take exception to, and it will be generally conceded that Mr. Headley has succeeded well in the aims he set before himself. He has produced a very instructive and thoroughly scientific book expressed in popular language, and one that will undoubtedly "prove useful," as he hopes it may, "to lovers of birds"; and, from the clear and concise manner in which the story of the bird's pedigree and life-history is narrated, it will be specially welcome to those of them who have not had the advantage of a scientific training in the subject; while it can scarcely fail to attract many of its readers, on the outlook for a spare-time occupation, to the study of ornithology, on which it will start them with a trustworthy groundwork.

OUR BOOK SHELF.

Fern Growing. Fifty years' Experience in Crossing and Cultivation, with a List of the most Important Varieties, and a History of the Discovery of Multiple Parentage, &c. By E. J. Lowe, F.R.S., F.L.S., &c. (London: John C. Nimmo, 1895.)

MR. LOWE'S name is so well known in connection with the production of hybrid ferns, that his book will be opened with interest by all those to whom the cultivation of these plants in any way appeals. But we must confess that the book falls somewhat short of our expectations.

It is true that a very considerable space is devoted to the history of the production of hybrid forms, and that an account is given of the methods of securing successful germination of spores; but those who expect to find a treatise on the cultivation of ferns *per se*, will not find their hopes realised.

The author again takes up cudgels in defence of his views as to the existence of *multiple parentage*, a term used to express his conviction that a single oosphere can be fertilised by several antherozoids, or at the least, that a number of fertilised oospheres on one prothallium can influence the one which actually develops into a seedling plant. It is true that some of the experiments adduced by the author in support of his contention offer startling results. Thus, if a pan be sown with the spores of, say, four varieties, in a large percentage of the seedlings each will exhibit resemblances to all the four forms, instead of to only two, at most, of them. And this latitude of variation exercised in the case of a single seedling is stated to depend on the number of varieties which are sown together, and not to accidental sports.

But the inferences thus drawn by the author are so entirely at variance with the results of experimental investigations on the higher organisms, that they will meet with a cautious reception, at any rate, until the factors which make up his results have been analysed and are better understood.

Whatever the ultimate verdict which will be passed on the theoretical conclusions may be, the details of the experimental basis on which they rest, provide interesting matter enough, and suggest fresh lines of investigation which may well prove fruitful in results.

Vorlesungen aus der analytischen Geometrie der Kegelschnitte. By Sigmund Gundelfinger. Edited by Friedrich Dingeldey. 8vo. viii. + 434 pp. (Leipzig: Teubner, 1895.)

THE first part of this book (pp. 1–240) is an edition of lectures on Conics delivered by Gundelfinger within the last twenty years in the University of Tübingen and the Technical School at Darmstadt. It contains a systematic exposition of the analytical theory of Conics based on the use of general homogeneous coordinates which are so arranged that corresponding results in particular homogeneous coordinates and in ordinary Cartesian coordinates can be written down from the results obtained. It also contains an exposition of the theory of sets of Conics, including four-point and four-tangent Conics, and nets and webs of Conics. The theory is not written out with the idea of enumerating all the independent concomitant forms, but with the idea of expressing the geometrical significance of the most important ones. The appendix (pp. 240-426) contains solutions of problems on the subjects treated in the first part. Many of the problems are taken from the works of Steiner, some are original, and not a few are difficult. A very complete index is given at the end of the book.

Light. By H. P. Highton, M.A. Pp. 243. (London: Rivington, Percival, and Co., 1895.)

BOOKS upon light are many and of various qualities, but we think there is room for this little one. The subject is treated in a very elementary manner, and is made easy of comprehension by numerous diagrams. A further good point possessed by the book is that the lessons comprised in it are fully illustrated by experiments, all of which are capable of being carried out by teachers whose apparatus cupboards only contain a small stock of materials for the demonstration of optical facts and principles. The boy who goes through a course such as that described by Mr. Highton, and who sees all the experiments performed, will obtain a fair notion of the laws of light; and if he does the experiments himself, he will benefit considerably by the manual and mental training which his work will give him.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Curious Aerial or Subterranean Sounds.

IF the mysterious sounds referred to by Prof. G. H. Darwin should turn out to be of subterranean origin, as is not unlikely the case, it may be that they are the reports arising from the process of "faulting" going on on a small scale at a great depth, and not of sufficient intensity to produce a perceptible vibration at the earth's surface. In this connection I may recall an observation which bears upon the subject. When collecting materials for the report on the East Anglian earthquake of 1884, I was given a most circumstantial description of a loud report which was heard by the chief officer of the coastguard station at West Mersea during his watch between 1.10 and 1.20 a.m. on February 18 of that year. The sky was cloudless at the time, there was no flash such as might have been expected if the sound had been due to thunder or the explosion of a meteorite, and there was no artillery sufficiently within hearing to account for the sound. This report heard by the coastguard officer was afterwards found to have been *felt* as a slight shock at a house which was very much damaged by the earthquake which occurred a few weeks later (April 22), and we came to the conclusion that the officer and the inhabitant of the house in question had independently recorded a premonitory shock ("Report," p. 40, by the writer, and W. White, "Essex Field Club Special Memoirs," vol. i.). When Prof. Darwin's request for information shall have led to further knowledge as to the localities where the phenomenon has been observed, it would be of great interest to have in such places instruments for recording earth tremors. R. MELDOLA.

November 3.

Is it not possible that the "Berisàl Guns" and "mist pouffers," referred to by Prof. Darwin (p. 650), are merely earthquake sounds, the attendant shock being too slight to be otherwise perceptible? Nearly all earthquakes are accompanied by a rumbling sound, due, I believe, to the small and rapid vibrations proceeding chiefly from the margins of the area over which the fault-slip producing the earthquake takes place (*Geol. Mag.*, vol. ix., 1892, pp. 208–218). In some districts (Comrie in Perthshire, East Haddan, in Connecticut, Pignerol in Piedmont, Meleda in the Adriatic, &c.), sounds without shocks are common during intervals which may last for several years, but slight shocks with sound occasionally intervene, as if the sounds and shocks were manifestations, differing only in degree and the method in which we perceive them, of one and the same phenomenon. In great earthquakes, the sound-area is confined to the neighbourhood of the epicentre; in moderate and slight shocks the sound-area and disturbed area approximately coincide, or the sound-area may even overlap the disturbed area. In the limiting case, the disturbed area vanishes, and the vibrations are perceptible only as sound. C. DAVISON.

Birmingham, November 1.

Thermal Conductivity of Rocks.

IN view of recent discussions in NATURE anent the variation of the thermal conductivity of different kinds of rock with the temperature, the following results of an investigation, which has been in progress for the last year in the Jefferson Physical Laboratory, may be of interest.

We have made observations upon piles of comparatively large flat slabs of marble and slate by a form of "wall" method, and we hope that we have determined, with some accuracy, the internal temperature gradient.

We can detect no change in the conductivity of the block of white Carrara marble which we have used between 0° C. and 330° C.

In the case of our slate, the conductivity in a plane perpendicular to the cleavage increases about 25 or 30 per cent. between 70° C. and 300° C., the rate of increase being less rapid at the higher temperatures. B. O. PIERCE.

Cambridge, Mass., October 20. R. W. WILLSON.

MacCullagh's Theory of the Æther.

MR. BASSET'S criticisms in his letters in NATURE of October 17 (p. 595) and October 24 (p. 618) call for some reply. I willingly avail myself of the opportunity to attempt to make my meaning clearer.

(1) As regards the first letter, there seems to be some misconception. I have nowhere in the papers referred to given a proof, such as he supposes, of the theorem which he calls in question, viz. that a gyrostatic æther may be constructed which will function according to MacCullagh's optical scheme. That proposition is, I take it, Lord Kelvin's; and I simply gave references to his treatment, which occurs, at any rate implicity, near the end of the third volume of his "Collected Papers" (pp. 442, 466).

The principal aim of the second of the papers referred to (*Phil. Trans.* A, 1894) was, assuming the existence of a continuous medium with kinetic and elastic energies given by MacCullagh's expressions, to examine how far such a medium would fulfil the functions that are required of the æther, as (i.) the transmitter of radiation, (ii.) the medium in which electric actions consist and are transmitted, (iii.) the underlying medium in which ordinary matter may itself consist, in the form of permanent configurations of strain or motion possessing mobile characteristics. In MacCullagh's own time it was recognised, by none more than by himself, that a medium like his was in no way analogous to ordinary elastic matter. Moreover it was held by many that it was an impossible constitution for any medium at all. This latter conclusion I combatted by quoting the fact that Lord Kelvin has actually shown how to make a model, representing MacCullagh's medium, by means of a cellular structure composed of portions of ordinary matter in spinning motion. This is the only way that I intended to introduce the gyrostatic æther into the argument. For I hold it to be more rational to take matter to be a structure of molecular type in the primordial medium (which is not itself matter, but is a *continuum* with simpler fundamental properties than elastic solid matter) than it would be to take the æther to be a molecular or cellular structure built up out of ordinary matter.

The functions required of the æther show that it must be a medium which can have kinetic energy involving inertia, and also elastic energy of some kind when strained. According to MacCullagh's scheme, its elasticity would consist simply in resistance to absolute rotation; so that an element of volume of the medium is taken to have relations to directions in space, of the same general type as the axis of a spinning gyrostat actually possesses. The analysis of the interaction of this inertia and this elasticity forms a dynamical theory of the medium, but the dynamics is not the dynamics of ordinary matter.

Mr. Basset easily arrives at inconsistencies by applying MacCullagh's energy formula directly to the structural gyrostatic medium of Lord Kelvin. The reason is that the problem is one involving ignored coordinates (in the phraseology of Thomson and Tait's "Natural Philosophy") corresponding to the latent spinning motions of the imbedded gyrostats. Before the principle of least action can be applied after the manner of an ordinary continuous elastic medium, the actual energy function of the gyrostatic medium must be modified in the well-known manner, and it will thus assume a form equivalent to MacCullagh's. It would, no doubt, be interesting and instructive, as regards dynamical principles, to establish this in detail; but this is hardly the place to enter into a technical problem.

(2) As regards Mr. Basset's second letter, on the reflection of light from the surface of a magnet, the parallel which he draws between one type of theory which I provisionally uphold, and another which I reject, is, I think, not a real one. The latter theory retains the dynamical equations and surface conditions which belong to the luminiferous medium under ordinary circumstances, merely adding on to the electric force a new part of magneto-optic origin. This would hardly be open to objection if it worked; but it is admitted that it does not work, and in default of a specific reason being assigned for the discrepancy the theory fails. It is as if a machine, whose mode of working is thoroughly known under certain simple conditions, were observed to be working steadily under more complicated circumstances, while a mathematical analysis showed that it ought to get jammed under these new conditions. The inference would, I think, be that the machine has been reset, or some change made in its constitution, which obviated the jamming. Now the ordinary equations of the electric theory of light are, presumably, deducible from the energy function of the medium by the principle of least action. When the substance that transmits the light is in an extraneous magnetic field, there is a subsidiary term in the energy function which arises from this field; therefore the application of the principle of least action will now give different equations of the medium, and different boundary conditions, from those which ordinarily hold good. The statement that the boundary conditions which held for non-magnetic circumstances are not now maintained, is not to the point; the question is rather, whether the boundary conditions which are appropriate to the actual formulation of the problem can all be maintained, and if they can the theory is consistent.

J. LARMOR.

St. John's College, Cambridge, October 25.

Lightning.—Chain Formation.

ON September 9, 1895, I was cycling near Pitlochry, N.B. The day had been extremely hot—80° F. in the shade—and as dusk came on it grew somewhat foggy, and flashes of distant lightning became frequent. At ten o'clock there suddenly came on a terrific thunder-storm. Crash succeeded crash, and the lightning, of all colours, blazed almost continuously. Objects fifteen miles off could be seen as plainly, if not more so, than in bright daylight. The rain soon turned the road into a torrent, and my electric lamp failed to act properly. But the chief peculiarity was the occurrence of eight strange flashes of a chain formation, with large elliptical links, and of a golden-yellow colour. These flashes were not rapid in their passage, as ordinary lightning is wont to be; but one of them took slightly over a minute to pour from the clouds to the edge of the valley opposite me. Two of these chains of living, burning gold passed between adjacent clouds, while the remaining six came to earth, one in the field just beside me. I then went off to seek for shelter; but the storm continued till 1 a.m.

WILLIAM CRAWFORD.

Personal Injury from a Fire-ball.

IN compliance with a wish expressed by several scientific friends, I place on record an instance of damage done by a fire-ball or globular lightning. About five weeks ago, when I was in Londonderry, the circumstances were related to me by Mr. James Harvey, of Northland Road in that city. Mr. Harvey was staying during the month of August at Culdaff, on the north coast of Donegal; and on the 24th of that month, at about 4 p.m., a little boy named Robert Alcorn, whose parents occupied a house near Mr. Harvey's, was desired by his father to go into the yard and drive away some fowls from the door. On going out of the house, the boy saw a large bright object in the sky about the size of the table in his bedroom (I give his own account, leaving out necessary considerations of distances, &c.), or apparently about six square feet in area. The object came towards his house from the west, or north-west; and when it came close, it partly burst with a report like that of a gun. He put his hands over his face to shield himself from "the spark," and after the explosion the bulk of the ball appeared to continue its course towards the east, low down. When it burst, however, it struck him, shattering the thumb and the first and second fingers of the left hand, cutting, scratching, and blackening the right hand and left cheek, and shattering into fragments several bone buttons on his coat. Very soon afterwards, Dr. R. Young, of Culdaff, and Dr. Newell, of Moville, attended the boy, and amputated the fingers and a portion of the thumb.

No one near the place *saw* the ball (except the boy, of course), but the parents and several others heard the report, and the boy's father rushed out immediately and caught his son as he was falling. Mr. Harvey soon afterwards examined the place, and could find no further trace of the fire-ball, except that a piece of bark had been knocked off a small tree within a few feet of the place where the boy was struck. The local police made exhaustive inquiry as regards the possibility of any one's having fired a gun at the boy, or of his having had any explosive in his possession; but nothing of the kind transpired.

It is well to add that at Redcastle (about eight miles away), one of the residents saw, on the same day, a bright object in the sky, which object he took to be a fire-ball. The day was stormy, with heavy showers, but no thunder.

M. Jamin relates ("Cours de Physique," tome premier, p. 470) several instances of globular lightning, and from these I select

the following as bearing, perhaps, the greatest resemblance to the above case as regards atmospheric conditions :—

"À la suite d'un violent orage observé près de Wakefield, le 1er mars 1774, lorsqu'il ne restait plus dans tout le ciel que deux nuages peu élevés au-dessus de l'horizon, M. Nicholson voyait à chaque instant des météores semblables à des étoiles filantes descendre du nuage supérieur au nuage inférieur."

October 28. GEORGE M. MINCHIN.

The Dispersal of Acorns by Rooks.

IN peat-mosses, on open chalk downs, and in ploughed fields, often a mile or more from the nearest mature tree, one constantly finds acorn-husks and also seedling oaks, which last a few months or, perhaps, a couple of years, and then die, the conditions being unfavourable. It has always seemed to me, while studying the origin of the existing fauna and flora of Britain, that this dispersal of acorns ought to give an important clue to the means by which this country was again clothed when the climate became more genial after the Glacial Epoch. The oak has the largest seed of any British plant, and if it can be carried distances of a mile or more, it is evident that the whole of our present flora may have spread more rapidly than is usually imagined, and may have crossed straits and wide rivers.

I have for several years noted the position of these seedling oaks, finding them in places where no mammal would take the acorns. For instance, they are common in any of the New Forest peat-bogs that are within a mile of an oak-tree. They are common also in some places on the top of the escarpment of the South Downs, half a mile from oaks, and 300 or 400 feet above them. They are always associated with empty acorn-husks, stabbed and torn in a peculiar way.

In October and November rooks feed in the oak-trees, and I have long felt convinced that they were mainly responsible for the dispersal of acorns, though it is not easy to catch them actually doing it. On October 29 of this year I was successful. In the middle of an extensive field, bordered by an oak-copse and scattered trees, a flock of rooks was feeding and passing singly backwards and forwards to the oaks. On driving the birds away, and walking to the middle of the field, I found hundreds of empty acorn-husks, and a number of half-eaten pecked acorns, which had not had time to change their colour—a cut acorn changes colour on exposure to the air like a cut apple, though not quite so fast. This showed that the birds had been disturbed in the middle of their feast, for the marks on the acorns were quite unlike those made by a rodent or any mammal. They were stabbed and pecked, and the husks were torn off in strips, usually starting from a puncture. It was also noticeable that many of them were not shed acorns, but were accompanied by acorn-cups, the stalks of which had been bitten to tear them off the trees. This was singular, for the ground beneath the trees was covered with shed acorns. The rooks, however, were in the trees, not under them, and the reason for the selection of acorns in cups is probably that they are easier to carry—a shed acorn must be an awkwardly large and slippery thing for a rook's beak, one with a stalk will be more convenient. Several uninjured acorns were found, and most of the remains occurred on smooth spots of short turf—places where a slippery acorn might conveniently be pecked without being lost. One almost uninjured acorn had been driven by a single peck deep into the soft soil of a mole-hill.

It might be thought that it would be much simpler for the rooks to feed on the ground beneath the trees. Some of them apparently do so; but the majority seem always to carry the acorns into the open. The rook is a suspicious bird, quarrelsome, and a born thief. He seems particularly to object to a comrade watching him from any post of vantage, and the rooks when among the oaks, for some reason or other are always quarrelling, notwithstanding the abundance of food. An acorn dropped on rough ground or in a peat-moss would stand a great chance of being lost in some crevice or soft place; but the oak seeds so freely, that the bird need not waste time trying to recover the lost acorn—there are plenty more on the tree.

In this way oak-woods must spread rapidly. But we still want observations as to the distance to which acorns can be carried. I have seen seedling oaks at a distance of a mile from the nearest mature tree (not necessarily the tree from which the acorn came), and have found the characteristically torn husks somewhat further away. Do rooks roosting in elm-trees ever carry home acorns for supper? There used to be a number of rooks which roosted in elms near Brighton in the autumn and winter, but crossed the Downs to feed in the Weald. I have often watched them returning at dusk. Do they ever bring acorns from that distance? This flock may have been responsible for the seedling oaks near the edge of the Downs; and if it could occasionally bring an acorn still further, to Brighton, it is evident that the oak may have crossed the Strait of Dover, when it was somewhat narrower, and that Britain, as far as the oak shows, may have been continuously an island since the Glacial Epoch. CLEMENT REID.

On the Audibility of Fog Signals at Sea.

IN NATURE of August 8, attention was called to some recent investigations, published in *Hansa*, on the inaudibility of fog-horns at sea within certain zones surrounding the signal, although the horn is distinctly heard outside of such regions. It seems strange to me that I can find nowhere suggested that this may be a phenomenon of interference similar to that suggested in light by Dr. Lloyd of Dublin (*Trans. Roy. Irish Acad.*, vol. xvii.).

If we let x equal the distance of the observer from the signal, h and y the heights of the signal and the observer, respectively, above the level of the sea, and δ the linear difference between the paths of the reflected and the direct rays of sound, then

$$x = \frac{1}{2\delta}\left\{\delta^4 - 4\delta^2\,(y^2 + h^2) + 16\,h^2 y^2\right\}^{\frac{1}{2}} = \frac{2\,hy}{\delta}$$

approximately. An attempt to apply this formula to the observations recorded in the Report of the American Light-House Board, published in 1894, was foiled by the lack of sufficient data for substitution in the above formula. However, if $h = 100$ ft., $y = 30$ ft., and δ be taken for a wave-length of 2 ft. (which are probable values for the variables), then we would expect minima of sound at 1·1 and 1/3 miles, the maximum between these being at a distance of half a mile from the source of sound, which quantities are of the right order of magnitude. These distances might be modified considerably by refraction, the wind, and to some extent by the tide. When there are two minima, as in the *Hansa* experiments, this seems a much more probable explanation than that by refraction alone generally offered, and it explains the phenomenal loudness outside the silent area. The above equation shows that the boundaries of the silent regions in vertical planes are hyperbolas, which is essentially different from what the refraction theory gives. F. E. FOWLE.

Washington D.C., U.S.A., October 21.

To Friends and Fellow Workers in Quaternions.

IN NATURE for October 3, 1895, there is a letter, signed by P. Molenbroek and Shunkichi Kimura, on promoting the study of quaternions and allied systems of mathematics. I notice that this has not, as yet, been responded to in NATURE. I do not think that the subject should be allowed to drop; but that some permanent good should be done to science by making this branch of mathematics part of the compulsory course of study for students for the highest honours in mathematics in our universities and uuniversity colleges, in the hope that more workers may follow the subject up afterwards.

Unquestionably the calculus is of very great value in the higher natural philosophy, and in every sense will repay the trouble bestowed upon it, though I speak in all meekness and not as an eminent authority on the subject. May we hope for some information as to what form the literature of the International Association will take? G. H. J. HURST.

Eton College, Windsor.

The Colours of Mother-o'-Pearl.

HAD Mr. C. E. Benham given his address when writing to you on this subject (NATURE, vol. lii. p. 619), I should merely have taken the liberty of sending to him direct a copy of a paper entitled, "Prof. Blake and Shell-growth in Cephalopoda" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. i. pp. 421–427, June 1888), in which similar arguments to those of Mr. Benham were adduced. Now, however, perhaps you will permit me to refer Mr. Benham to Dr. W. B. Carpenter's report on shell-structure (*Brit. Assoc. Rep.*, 1844, p. 11). As for the text-book writers, who usually support their explanation of the iridescence of mother-o'-pearl by reference to the theory of

Brewster, they may be recommended to study his original paper (*Phil. Trans.*, 1814, p. 397), when they will see that such a reading of it is both incorrect and incomplete.

F. A. BATHER.

Natural History Museum, October 28.

THE STAR SHOWERS OF NOVEMBER.

WELL may Mr. Greg, in his catalogue of meteoric radiants, published in 1876, affix a remark indicating the all-surpassing character of the mid-November meteors. For if there is one star shower more striking than all the rest, it is assuredly the Leonids. Every one who has seen the phenomenon at its best, is prepared to admit that it furnishes a grander spectacle than any other system, and will have realised that, once seen, it impresses itself indelibly upon the memory. There can be very few people living now who witnessed the great shower in America on the morning of November 14, 1833, but there are many Englishmen who vividly remember the fine but less splendid exhibition of 1866. With a swiftness unsurpassed among meteor streams, and with a brilliancy quite their own, the Leonids belong to the most striking class of these bodies, and offer a great distinction to the slow and gentle flights of the Andromedes, or meteors of Biela's comet which present themselves about a fortnight later. It is true the Leonids are only manifested, in vast abundance, once in a generation, and that, considered as an annual display, they usually fall below the strength of the August Perseids. But, considering all things, the November shower is undoubtedly entitled to precedence. The writer saw the Leonids in 1866, he also observed the rich displays of Andromedes in 1872 and 1885, and has been fortunate enough to witness many bright returns of the Perseids and of other prominent systems; but, of all such spectacles, one only, by its surpassing splendour, created an impression which still lives fresh in the memory, and that was the Leonids of November 1866.

The similar display which occurred in 1833, may be regarded as a very auspicious event, since it attracted attention to an important branch of astronomy which had been systematically neglected. Men began to seriously regard a phenomenon capable of giving such a remarkable sky picture, and the facts relating to it were collected and discussed. But the meteor showers of 1833 and 1799 were understood to be very exceptional events, and they had not been observed with that attentive regard to details which is so essential in this class of observation. Astronomers, however, were led to suppose that historical records might contain references to similar phenomena witnessed in ancient times, and Herrick, Quetelet, Arago and others, on consulting old works, found a number of descriptions of star-showers preceding that of 1799, and obviously of the same character. These occurred in 902, 931, 934, 1002, 1101, 1202, 1366, 1533, 1602, and 1698. A list of the dates was given by Prof. Newton in the *American Journal of Science* for May 1864, and he found, on comparing the intervals separating the various returns, that these brilliant meteoric apparitions visited us four times in every 133 years. The descriptions of them were quaint and imperfect, and of little scientific value apart from affording an important clue as to the period of the swarm; but it may be interesting to quote from a few of them. In October 902, a vast concourse of falling stars were scattered over the sky as thick as rain. On October 19, 1202, "stars shot hither and thither in the heavens eastward and westward, and flew against one another like a swarm of locusts; this phenomenon lasted until daybreak; people were thrown into consternation and cried to God the Most High with confused clamour." A Portuguese chronicle thus refers to the shower of 1366: "Twenty-two days of the month of October being past, three months before the death of the king Don Pedro of Portugal, there was in the heavens a movement of the stars such as men never before saw or heard of. At midnight, and for some time after, all the stars moved from the east to the west, and after being collected together they began to move, some in one direction, and others in another. And afterwards they fell from the sky in such numbers and so thickly together that as they descended low in the air they seemed large and fiery, and the sky and air seemed to be in flames, and even the earth appeared as if ready to take fire." Coming down to modern displays, Humboldt saw thousands of bolides and falling stars succeed each other during four hours on the morning of November 13, 1799. The phenomenon returned in 1831 and following years, and the facts may be referred to seriatim:—

1831 November 13 a.m. An account of this shower was given to M. Arago by one of the officers of the French brig *Loiret*, as follows: "The sky being perfectly cloudless, and a copious dew falling, we have seen a number of shooting stars and luminous meteors of great dimensions. During upwards of three hours two per minute were seen. One of these meteors which appeared in the zenith left an immense train from east to west, like a luminous band, and the light it gave did not disappear for six minutes."

1832 November 13 a.m. Capt. Hammond, of the ship *Restitution*, then in the Red Sea, off Mocha, says: "From 1 a.m. until daylight there was a very unusual phenomenon in the heavens. It appeared like meteors bursting in every direction. On landing in the morning I inquired of the Arabs if they had noticed the above. They said they had been observing it most of the night, but had never seen the like before."

1833 November 13 a.m. The phenomenon continued during seven hours. At Boston the number of meteors was considered to equal one-half of the flakes which filled the air in an ordinary fall of snow. The number visible was estimated as upwards of 240,000. Another observer stated that between 4 and 6 a.m. about 1000 meteors per minute might have been counted.

1834 November 13 a.m. A large number of shooting stars seen in the United States.

1835 and 1836. Many meteors observed on same date. In the latter year, on November 13 a.m., an immense number of meteors made their appearance between midnight and daylight, but the display did not equal the shower of 1833.

1864 November 13 a.m. An observer on board the steamship *Ellora*, off Malta, wrote on November 14 as follows: "There was a grand display of meteors from midnight to 4h. a.m., all through the watch, the night before last. The watch, an old 'salt' and an intelligent man, said that it was the grandest shower he had ever seen." None were visible on the morning of November 14.

1865 November 13 a.m. Between 1h. and 5h. a.m. 279 meteors were seen by six observers at Greenwich, and it was computed that the total number visible during that period must have been fully 1000. Prof. Herschel noted 71 meteors between midnight and 3 a.m. At Cambridge University 98 meteors were observed between midnight and 2 a.m.

1866 November 14 a.m. 8485 meteors were counted by several observers at Greenwich. Mr. Wood, at Birmingham, estimated that between 1h. and 1h. 30m. a.m. meteors appeared at the rate of 3600 per hour. The maximum occurred at about 1h. 10m. a.m. when Dr. Burder, of Bristol, counted 80 per minute. From the combined observations of several persons looking in different directions, Mr. Lawton, of Hull, made the number of meteors to have been 144 per minute for nineteen minutes from 12h. 58m. to 1h. 17m. a.m.

1867 November 14 a.m. Weather generally unfavourable in England. At St. George, Grenada, there "was observed before day-break a shower of luminous meteors flying about in every direction and of every conceivable magnitude." At the University Observatory, Toronto, four observers counted 2287 meteors between midnight and 6 a.m. Of these 1345 were seen during the hour from 4 to 5 a.m.

1868 November 14 a.m. Many meteors seen in England, but the sky much overcast. At Rome, Secchi reported that 2204 meteors were counted between 2.30 a.m. and 5.45 a.m. At Toronto, Canada, 2886 meteors appeared between November 13 10h. 45m. p.m. and November 14 5h. a.m.

1869 November 14 a.m. Lieut.-Colonel Tupman, at Port Saïd, Lower Egypt, counted 136 meteors between 2.30 and 5h. 14m. a.m., and they were nearly all Leonids. At Santa Barbara, California, 556 meteors were noted by two observers in 2h. 25m. before 3h. 43m. a.m.

In 1870 moonlight partly interfered, but it was evident the meteor shower had lost its conspicuous character—a fact fully confirmed by observations in 1871. But it had not entirely disappeared, for in the years mentioned, and in those which succeeded, the middle of November always brought some of the swift streak-leaving meteors from the well-known radiant in the sickle of Leo.

In 1879 and 1888, on the morning of November 14, very distinct showers of Leonids were observed by the writer at Bristol, and in many other years they were also visible. Mr. Corder, at Bridgwater, saw a few Leonids in 1892, and, in 1893, Prof. Barnard, in California, described them as far more abundant than he had ever seen them before. Many very brilliant ones were seen, and they were especially plentiful on the mornings of November 13, 14 and 15. In 1894 moonlight interfered with observations.

This meteor system evidently forms a complete ellipse, for there seems no reason to doubt that it returns annually without a break. Even in parts of the orbit very far removed from the dense cluster, which seems identical with Tempel's comet (I. 1866), the meteoric particles appear to be pretty numerously distributed, for there were fairly active displays in 1879 and 1888. It is true the shower has not been observed every year, but there is good reason to assume its annual recurrence, and that it would be seen were the nocturnal sky free from clouds and moonlight just at the critical time.

One of the most important features of a meteor shower is that the flights are directed from a common centre, and no observation of such a shower can be regarded as complete unless the radiant point has been determined. The writer has generally found the radiant of the Leonids very sharply defined, and it admits of being accurately detected even by observers who are inexperienced, for the meteors leave luminous streaks, and these, lingering for one or two seconds, enable the directions to be correctly registered. The Leonid radiant has been frequently obtained, and the following are some of the values given by different observers in various years.

1833	November 13 a.m.	148°	+24°	Aiken.
,,	,, ,, ...	150	+20	Olmsted.
1836	,, ,, ...	150	+20	G.O.S. New York.
1865	,, ,, ...	148	+23	A. S. Herschel.
,,	,, ,, ...	148	+23	Newton.
,,	,, ,, ...	148	+24	Marsh.
1866	,, 14 ...	149	+23	Mean of nineteen positions by the best observers.
1867	,, ,, ...	147¾	+23	Bradley.
,,	,, ,, ...	150¾	+22	Watson.
,,	,, ,, ...	148	+23	Harkness.
,,	,, ,, ...	150½	+22½	Sands.
1868	,, ,, ...	152	+18	Gilman.
1869	,, ,, ...	151	+22	Tupman.
1877	,, ,, ...	146	+26	Backhouse.
,,	,, 11-14 ...	148	+24	Denning.
1879	,, 14-16 ...	147	+23	Perry.
,,	,, 16 ...	151	+22	Sawyer.
,,	,, 12-14 ...	148	+25	Corder.
,,	,, 14 ...	148	+23	Denning.
1880	,, 12-13 ...	148	+22	Sawyer.
1885	,, 15-18 ...	150	+22	Denning.
1887	,, 15 ...	155	+25	Booth.
,,	,, 15 ...	150	+22	Denning.
1888	,, 14 ...	149	+22	Denning.
1890	,, 14-15 ...	151	+24	Backhouse.

In addition to these, some good positions are given in the catalogues of radiants by various authorities, thus :—

November 10-14 ...	148°	+22°	Schmidt.
,, 7-15 ...	153	+22	Greg and Herschel (1863.)
,, 12-13 ...	148	+24	Heis.
,, 11-15 ...	149	+23	Greg (1876).

The mean place derived from a large number of positions, agreeing well amongst themselves and individually fixed by the most trustworthy observers, is at

$$149^\circ{\cdot}15 + 22^\circ{\cdot}9$$

This is almost identical with that of the naked eye star Piazzi IX. 230 (mag. 5·7). the place of which in 1880 was

$$149^\circ{\cdot}1 + 22^\circ{\cdot}5$$

Relatively to the bright stars forming the sickle of Leo the radiant is situated as in the following diagram :—

Place of the Leonid Radiant amongst the Stars in the Sickle of Leo.

It is of no utility beginning a watch for Leonids before 10.30 p.m., as the radiant does not rise until about that time. It is very rarely that a meteor is seen from a radiant on or a little below the horizon, but a remarkable Leonid was observed in 1879 November 13, as early as 10h. 20m. at three different places, viz. Writtle, Bedford and Bristol. As seen from the latter place, the meteor passed through an arc of 90°, the observed path being from 98° + 22° to 4° − 15°.

The interest in this meteor shower is now rapidly increasing, for we are drawing near the period when brilliant returns may be expected. Two years preceding the maximum, as in 1831 and 1864, we may certainly look for rich displays, so that November 1897 will form an important epoch. It is also in the highest degree probable that in 1895 and 1896 the shower will give decided indications of returning activity. This year the conditions will be very favourable, as the moon, being a slender crescent and within a few days of the new, will be unable to make her influence felt.

The shower of Leonids certainly endures from November 9 to 17, but the really brilliant displays only last a few hours, and these at the end of the present century will occur either on the mornings of the 14th or 15th. 1896 being leap year, the phenomenon may be expected earlier than usual. The year 1898 offers prospective events of extraordinary interest to the meteoric observer, for two brilliant displays may occur within ten days of each other. The Leonids will be due on November 14, and the Andromedes on November 23.

As to the nature of the observations necessary during the progress of a meteor shower, it may be suggested that two persons are required to fully note the features presented. One will record the number of meteors appearing during short intervals, say of five minutes, so

that the time of maximum may be ascertained as well as the aggregate number visible during the period covered by the watch. The other will register the individual paths of well-observed meteors on a star chart or celestial globe, determine the place of the radiant and its character, especially note large meteors and any other peculiarities that may offer themselves. One observer, working single-handed, may do a great deal by dividing his attention between the various points alluded to. It is always important to separate the number of meteors visible in a special shower from the total number seen, for the aggregate counted must exceed the actual strength of a particular stream, since it includes the sporadic meteors. When reckoning the visible meteors, therefore, the observer will do well to keep an account of the number unconformable with the radiant of the main display. The radiant of the Leonids can be readily assigned, not only because of the afterflows or phosphorescent streaks left by the meteors, which assist the eye in fixing their exact directions, but also on account of the well-known asterism involving it. The Leonids exhibit a more contracted area of radiation than the Andromedes, but it is a feature not yet thoroughly investigated. By selecting a number of well-observed tracks near the radiant, the extent of its diffusion may be readily determined. The writer has sometimes found the centre so definite that the conformable paths have intersected at a point.

W. F. DENNING.

THE OLD AND NEW NATURALISTS.

NATURALISTS, like the animals and plants of which they discourse, are subject to the process of evolution. The naturalist of the latter end of the nineteenth century is not quite the same species as that which bore the name at the end of the eighteenth. Differentiation has been at work. So markedly indeed is this the case, that one is tempted to ask whether the species, as such, is not well-nigh extinct. To-day there are biologists, comparative anatomists and physiologists, systematic botanists and systematic zoologists, palæontologists and embryologists. But where is the naturalist? Has he not been swallowed up by and distributed among his polyological progeny? And yet the word is still in use, and carries with it a more or less specialised implication. The other day a friend, who was discussing with me the work of an acquaintance, said: "He's a capital anatomist; it's a pity he's not more of a naturalist"; and I had no difficulty in catching his meaning. It may be worth while to consider the relative position and status of the old and of the new naturalist.

In one of his luminous essays—that on the study of biology—Prof. Huxley reminds us that Hobbes of Malmesbury (Leviathan Hobbes) said: "The register of knowledge of fact is called history. Whereof there be two sorts, one called natural history; which is the history of such facts or effects of nature as have no dependence on man's will; such as are the history of metals, plants, animals, regions, and the like. The other is civil history; which is the history of the voluntary actions of men in commonwealths." In Hobbes's terminology, then, naturalist was synonymous with man of science. Indeed, until quite a recent date, as I am told, the Professor of Zoology in one of our northern universities bore as his technical title the designation Professor of Natural and Civil History. Gradually the field of the naturalist was restricted. Those branches of science which seemed to be specially susceptible of mathematical treatment were allotted to the natural philosopher; the naturalist, as such, continued to deal with physical geography, geology, mineralogy, and the history of plants and animals. The names of Buffon and of Humboldt at once rise to our minds as those of naturalists of this encyclopædic type. But the progress of knowledge, and the vast accumulation of facts, necessitated further division of labour; and by this further differentiation the field of the naturalist was yet further limited to the natural history of animals and of plants. Nor did the process of differentiation stop here. To-day we have herpetologists and ichthyologists; we have zootomists and embryologists; we have systematic botanists and evolutionists; but where, one may again ask, is the naturalist?

I take it that the term "naturalist," as we now use it, implies the sympathetic study of animals and plants in their varied relations to each other under the natural conditions of their customary habitat. In short the naturalist is in great part what Prof. Ray Lankester would call a student of bionomics, or what Semper called an investigator of the higher physiology of organisms. His calling is a protest, first, against the wide-spread error that physiology ends with the individual; and secondly, against the no less erroneous view that science ends with analysis. The naturalist sees in the individual animal or plant merely a constituent unit in a connected whole; and welcomes the most minute analysis chiefly as a means to a more complete synthesis.

Looking back to naturalists of the past in the light of this conception, it is of Gilbert White of Selborne that we feel the term to be exactly descriptive; and in the old days it was the man of leisure like White, the sportsman like St. John, or the angler like Izaak Walton, that was the best and most characteristic naturalist. They started with no equipment of special training, indeed, but with a keen eye, an observant habit, and a generous love of all that ran wild and all that grew free in the face of heaven. They gave their hearts to nature for its own sake; their lavish interest therein had no ulterior motive; they accepted the plain unvarnished tale of creation, and were troubled by no problems of evolution, and in their writings their main object was close, accurate, and sympathetic description rather than reasoned and logical explanation.

Nor can we read the works of the older naturalists without feeling that they were humanists as well. It is true that the more typical humanists of their time regarded their naturalist proclivities in the light of amiable eccentricities, as hobbies with little or no intimate bearing on man, the central figure in all rational and serious study and investigation; little dreaming of the influence natural history was destined to exercise in their own proper sphere of work. But the naturalists were wiser than they knew; wiser perhaps than some modern humanists on the one hand, and some modern naturalists on the other. They included man in their field of view.

Is it too much to say that the connecting link between the old and the new naturalists is to be found in Charles Darwin? The author of the "Naturalist's Voyage" had received but little systematic training, as we now count systematic training; he had the keen eye and the observant habit; he had the generous love for, and sympathy with, nature in all her aspects; he was indeed an encyclopædist in his width of interests, which included physical geography and geology as well as the world of plants and animals; and man was assuredly not absent from his field of view. Is any one likely to question the assertion that Charles Darwin was a great naturalist of the old type? And after more than twenty years of experimenting, investigating, collecting an enormous mass of data, and thinking of the careful patient type which brilliant little bodies even now fail to appreciate, he gave to the world his "Origin of Species," by which the work of all future naturalists was set in a new light. And after that, did he not write his "Orchids," his "Insectivorous Plants," his "Climbing Plants," his "Earthworms," all of them full of the spirit of the new natural history? Had Darwin made another voyage, and had he given us another journal of a naturalist, what we should have

looked for would have been a new description of the animal and vegetable world in their natural relations under the observed conditions of their life, interpreted in the light of the new principles which he himself had gone so far to establish. And this, as it seems to me, marks out the field of work of the naturalist of to-day and to-morrow. He must have grasped the nature of the great biological problems which the latter half of this century has opened up; he must retain the keenness of eye and quickness of observation which characterised the older naturalists; he must deal chiefly in accurate and graphic description, and not too much indulge in speculation—keeping his more speculative work for other modes of presentation; but he must also be to us the interpreter of the facts of animal and vegetable life *as it is lived in the open face of nature*, in terms of recognised principles of biology, and yet wholly without prejudice, forcing no dogma upon nature, expecting daily to discover new truths, and aware of the provisional character of so many of the conclusions of the evolutionist.

If then we attempt to define the naturalist, we may say: first, that his subject-matter is animate nature as it is; the inter-relations of living things in the web of life, the bionomics or higher physiology of organisms. Secondly, that his method is primarily observational; but that, if the synthetic picture is to be achieved, he must be aware to the full of the results of analysis in physiology, psychology, and ætiology. And thirdly, that his mood must be sympathetic, and that to be successful in his presentation he must combine the qualities, not only of the man of science, but also of the artist.

While much admirable and fascinating work has been done by traveller-naturalists in many parts of the world, it must be remembered that there is abundant work for the stay-at-home naturalists in the ponds and hedgerows, woods and shores, of our own country. The members of our field-clubs may do excellent service to the general cause of natural history. But, without denying the value of cataloguing the local faunas and floras, we must recognise that many field-clubs and naturalists' societies err in confining themselves too exclusively to this. Precise observations as to the habits of animals, and the environmental relations are needed even more urgently than systematic work of this kind.

And here a word or two may be said on "Natural Histories." Most of the natural histories of animals have not sufficiently shaken themselves free from the bondage of the systematist. They are to a large extent hybrid works with a foundation of more or less popularly expressed systematic zoology, and sections or paragraphs on habit and instinct. Brehm's "Tierleben" is, however, a treasure-house of observations as to the life and habits of animals to which Darwin and many others have freely acknowledged their indebtedness, while others have not. The "natural history," as such, should have for its primary subject the inter-relation of animals and plants, the web of life as it is presented to our study; and to this all reference to anatomical structure, systematic position, and individual habit, should be made subsidiary. In botany, Kerner's great work, a translation of which by Prof. Oliver is now published, affords an admirable example of what a natural history should be. The bionomic note is here distinctly dominant.

Of course under the new conditions of the present time the preliminary training of the naturalist needs to be both wider and fuller than was either possible or necessary for the older naturalists. He must be not only well read in, but must have real practical acquaintance with, physiological and biological investigation. There is, moreover, one point in connection with the preliminary training of the naturalist which appears to me to be important. In his description of animal life he will have to interpret many of their actions in terms of the underlying mental processes. To do this with any success he should have a training in psychological methods. Such training has been too much neglected in the naturalists of the past; and even now it is often assumed, or so it would seem, that whereas when biological problems are concerned, the guidance of untrained mother-wit is, by itself, scarcely adequate, yet, when psychological problems are concerned, this is amply sufficient.

That his work may be effectual, the naturalist should be not only a man of science but a man of letters. This will give to his interpretation a special value. But he must be both in equal degree. He must not, as is too often the case with magazine writers, regard natural history as merely a subject on which may be written a certain number of bright and pleasing pages which shall not require any undue amount of exercise of thought on the part of his readers. Not that in saying this I would utter one word in disparagement of such writers as Kingsley, Jefferies, and Burroughs, of Mr. Warde Fowler, and a number of keen observers who have made their observations the subjects of delightful essays. Nay, rather I would contend that these writers have done good service in illustrating the value of the sympathetic mood, in emphasising a healthy reaction against "mere necrology," in vindicating the right of the amateur to contribute towards the end all naturalists have in view. But I still feel that, for the naturalist as such, his first and foremost object must not be to give us pleasure by his manner and method, by his delicacy of touch and his imaginative treatment; it must rather be to tell us something which in and for itself is worth knowing, since it will give us a deeper and truer insight into the world of living things. Literary finish, grace of style, imagination and graphic power should be there; but this should be like the cutting and polishing of the gem which, though it enhances its value, does not by any means constitute the chief element thereof.

The species naturalist, then, is not dead but liveth. It includes not only the professional, but the so-called amateur. The naturalist has been of late in La Plata, in Borneo, in Celebes; he has told us of the wonders of animal life on the ocean surface; he has watched the struggle for existence in a tropical forest and on the sea-shore; he is at work among aquatic insects, and learns the ways of birds and insects on Bindon Hill; he knows not only the zoology but the natural history of rotifers, and can discourse delightfully to the Royal Microscopical Society on the unnecessary difficulties in the way of studying natural history; and he still looks out across the waters of Poole Harbour to Corfe Castle, and tells us of the days of his youth in the Malay Archipelago.

In conclusion we may say that just as the early poets were frankly and naïvely descriptive, so too were the early naturalists. Neither dealt in deep and subtle analysis. But the time of analysis came and flooded the world. The modern poet profits by all this analysis, is indeed a subtle analyst himself; but, as poet, he keeps his analysis out of sight, and gives us a new presentation of nature in descriptive and synthetic form. So too must the modern naturalist profit to the full by all the biological and psychological analysis of his times; but, as naturalist, he must keep all this out of sight, and give us a new presentation of animal and vegetable life in descriptive and synthetic form. And he must remember that his picture will not be complete unless it include man himself. For man is also in the web of life, influencing and being influenced by all around him; nowise to be ignored, but to be taken account of to-day as he was by Humboldt, and by the stronger naturalists of the old school. And this new descriptive presentation of nature, as it reveals itself to the eye and brain of the modern naturalist, will differ chiefly from that of his predecessor, first, in that it is no longer a piece of amiable eccentricity, but is in close touch with the

gravest problems that man has to grapple with; and secondly, in that it has more or less distinct reference to a past of which the present is but an outcome and a development. C. LLOYD MORGAN.

HERMANN HELLRIEGEL

PROF. HERMANN HELLRIEGEL, whose death took place at Bernburg, Anhalt, on September 24 last, was born at Pegau, Saxony, on October 21, 1831, so that he was within a month of completing his sixty-fourth year. His life, on the whole, was uneventful, for he devoted himself with studious zeal almost entirely to investigations, both chemical and physiological, into the phenomena of plant nutrition. One of his earliest official posts was that of Director of the Agricultural Experiment Station at Dahme, in Brandenburg, which was founded in 1857 by an association of agriculturists in Jüterbog-Rückenwalder. During his tenure of this post he studied experimentally the alimentary needs of certain plants which are cultivated as field crops, notably cereals, potatoes, and sugar-beet, his method involving the use of sterilised soil, both by itself and with the addition of various chemical salts. His physiological inquiries embraced observations on the growth and development of roots, on the quantity of water used in the growth and maturation of field crops, and on the minimum amounts of nitrogen, phosphoric acid, potash, and other ingredients required by plants. Supplemented by observations on crops grown in the open field, these investigations led Hellriegel to conclusions of great practical importance, notably in connection with sugar-beet, a crop which Germany grows more extensively than any other European country, its annual average area for the last twelve years having been 800,000 acres, or more than one-fourth of the entire European acreage.

It was with no little regret that in 1873 Hellriegel gave up his directorship at Dahme, though for a post with greater emoluments. But his capacity as an investigator had made its mark, and when in 1882 the Verein für Zucker-Industrie, in co-operation with the Government of the Duchy of Anhalt, established an experimental station at Bernburg, for the special investigation of problems bearing upon the cultivation of sugar-beet, it was felt that Hellriegel possessed special and peculiar claims to the directorship, which was accordingly offered to him. He accepted with avidity a post which enabled him again to devote his time and energy solely to those investigations into plant-life, which had previously exercised upon him so strong a fascination. The station at Bernburg is admirably equipped, and Hellriegel found himself in a position to at once resume his inquiries into the nutrition of leguminous plants, a subject that had previously received his attention at Dahme. It was here that after a dozen years' work he, in collaboration with Dr. Wilfarth, made the great discovery with which his name will ever be inseparably associated, namely, the capacity of leguminous (or at least of papilionaceous) plants to take up, or fix, through the agency of the micro-organisms of their root-nodules, the free or uncombined nitrogen of the atmosphere.

The intimation—the revolutionary announcement—of this startling discovery was made on September 20, 1886, in a communication to the Naturforscher Versammlung, held at Berlin, and over the agricultural chemistry section of which Dr. (now Sir Henry) Gilbert happened to be presiding—a coincidence of exceptional interest in view of the circumstance that Sir Henry Gilbert was one of the joint authors of the celebrated memoir by Lawes, Gilbert, and Pugh, "On the sources of the nitrogen of vegetation, with special reference to the question whether plants assimilate free or uncombined nitrogen" (*Phil. Trans.* 1861), which, at the time of its appearance, and for long after, was regarded as setting at rest the question as to the capacity of plants to assimilate the free nitrogen of the atmosphere, and of confirming upon this point the negative results previously obtained by Boussingault. Hellriegel's momentous discovery furnished an explanation of the long-known fact that a clover-crop leaves the soil richer in nitrogen than it finds it, and is therefore a suitable crop to precede the wheat-crop in a rotation, clover being—as we now understand through Hellriegel's discovery—a nitrogen-accumulating plant, and wheat a nitrogen-consuming one. Indeed, the fact itself is a very old one, for it was observed by the farmers of the Roman Republic that beans, lupins, vetches, and other plants belonging to the sub-order Papilionaceæ, as now defined, rendered the soil "more fruitful" for the crops that followed. But nearly 2000 years elapsed from the time when Varro recorded this, to that when Hellriegel, a brief nine years ago, supplied the explanation. It in no way detracts from the value and significance of the discovery that Hellriegel and Wilfarth should have happened upon it in the course of investigations which were really directed to quite a different object. Those who devote their lives to research are not unaware that gems, hitherto unseen, may sometimes be picked up on the wayside.

We have spoken of Hellriegel's discovery as revolutionary, and it certainly upset a long-cherished belief. The opposition which his announcement received at the outset was a testimony to its importance. Subsequent research, both in Europe and in North America, has, however, only strengthened the position which Hellriegel took up, whilst it has suggested new lines of investigation for which there will probably be no lack of workers. Bréal, Frank, Hiltner, Lawes and Gilbert, Schlœsing fils and Laurent, are but a few of the investigators who have proved the accuracy of the discovery made at Bernburg. In recognition of his work, Hellriegel was elected an honorary member of the Royal Agricultural Society of England, a rare distinction, which he enjoyed in common with such continental workers as Pasteur, Fleischmann, and Chauveau. In France his merits were recognised by his election as a foreign associate of the Société nationale d'Agriculture, and as a Correspondant of the Academy of Sciences.

NOTES.

THE German committee for the exploration of the South Polar regions met at Berlin on Sunday, and decided to send two vessels southwards from Kerguelen Island, leaving full liberty of action to the leaders. The total sum to be allotted for the expedition, which is to last three years, has been fixed at 950,000 marks (£47,500).

CHICAGO UNIVERSITY continues to be the recipient of Fortune's favours. Mr. John D. Rockefeller has (says the New York correspondent of the *Daily Chronicle*) added £200,000 to his previous gift of £800,000 for the endowment of the Chicago University. He promises £400,000 more if any one else will subscribe a like sum. When will the day come for such generous gifts to education and research in England?

THE Municipal Council of Arbois, the birthplace of Pasteur, has decided to erect a statue to his memory, and also to call the municipal college the Pasteur College.

M. BERTHELOT, the distinguished chemist, has been appointed Minister of Foreign Affairs in the new French Cabinet. He was Minister of Education in the Cabinet of 1886-87.

IT is reported that the Paris Municipality have granted £800 to the Salpêtrière Hospital for the erection of new buildings in which to treat nervous and mental affections by electricity.

THE Board of Agriculture have appointed a Departmental Committee to consider and report upon the arrangements which it is desirable to make for the sale and distribution of Ordnance Survey maps. The committee consists of the following gentlemen:—Mr. W. Hayes Fisher, M.P. (Chairman), Mr. H. Hobhouse, M.P., Mr. W. A. M'Arthur, M.P., Mr. F. a'C. Bergne (Treasury), and Mr. T. H. Elliott (Secretary to the Board). Mr. J. J. Thomson, of the Board of Agriculture, will act as the Secretary to the Committee.

THE new public museum which has lately been opened at Kasan, well deserves the attention of archæologists for its beautiful collections, the gift of A. Th. Likhacheff. The collections comprise a considerable number of golden and silver bracelets, earrings, rings, as well as of various arms and implements from the once powerful kingdom of the Volga Bulgars, on the seat of which Kasan now stands. The modern decorative art of the Kasan Tartars, as well as the dress and implements of the Chuvashes, Cheremisses, and Mordves, are also very well represented; while nearly 1500 stone implements illustrate the Stone age on the Volga and the Kama.

THE Zoological Department of the British Museum (Nat. Hist.) has recently acquired (by purchase) an important series of British fossils from the cabinets of the Rev. P. B. Brodie, of Rowington, Warwickshire. The specimens mainly illustrate the fauna and flora of the Mesozoic period, among them being several valuable types described by Owen, Egerton, Buckman, Wright, Duncan, Carruthers, Woodward, and other palæontologists. Some of the rarer genera include remains of *Hyperodapedon*, *Mastodonsaurus*, and *Cladyodon* from the Keuper sandstone of Warwick, each of which will be now represented in the National collection for the first time, from that locality.

IN September of next year, the Smithsonian Institution, which has exerted an immense influence upon the development of science in America, and which has done more than any institution to make the results of scientific work known unto the ends of the world, will celebrate its jubilee. It is stated by Dr. Brown Goode, in a historical account of the Institution, that a special volume will be published to commemorate the event, and two memorial tablets will be erected in honour of the founder in the city of Genoa, where he died June 26, 1829: one in the English church, and one upon his tomb in the beautiful little English cemetery on the heights of San Benigno.

REUTER reports the occurrence of a severe and prolonged earthquake shock in Rome at 4.30 on the morning of November 1. The Central Meteorological Bureau states that the movement of the earth began with very slight tremors, lasting from four to five seconds. Subsequently a series of strong shocks, which continued for nearly eight seconds, occurred. After a calm of a few seconds slight undulations were perceptible for about eight seconds. Two clocks in the observatory stopped, and the old tower of the Roman College was cracked a little. At Rocca di Papa, near Rome, a violent undulatory shock was felt at 4.40. It lasted seven seconds, but caused no damage. Shocks were also felt at Anzio, Velletri, Tivoli, Civita Vecchia and Fiumicino, all in the vicinity of the capital. At the latter place the earth movement was especially strong.

WE have received from Prof. G. Vicentini, of Padua, some interesting copies of microseismographic records of a distant earthquake on October 20. The instrument with which they were obtained has been briefly described in a previous note (vol. li. p. 540). The first movements, which Prof. Vicentini attributes to longitudinal waves, began about 9h. 30m., Greenwich mean time (whether a.m. or p.m. is not stated), and lasted about twenty minutes. The second series of pulsations, which he regards as due to transversal vibrations, and each of which had a period of about thirty seconds, attained their maximum intensity about 10h. 15m., and lasted until about 11h. 30m. Somewhat similar pulsations were also registered on October 4, the longitudinal vibrations commencing between 10h. 25m. and 10h. 30m., and the transversal vibrations (of long period) after 10h. 50m. So far as we are aware, no great earthquakes are known to have occurred on these days. If the disturbances are of seismic origin, they must evidently be due to very violent shocks taking place in some distant region of the globe.

THE death is announced of Dr. Albert E. Foote, of Philadelphia. Dr. Foote was born at Hamilton, in 1846. After graduating at Courtland Academy, Homer, N.Y., he entered the class of 1867 in the University of the State of Michigan, where he took the degree of Doctor of Medicine. He spent some time as an instructor at Ann Arbor, and also as Assistant Professor of Chemistry and Mineralogy in the Iowa State College. He removed to Philadelphia in 1875. He was a life member of the Academy of Natural Sciences, of the New York Museum of Natural History, and the American Association for the Advancement of Science. Dr. Foote's wide correspondence and extended travels made him well known, especially among mineralogists. His exhibits and lectures at the American Exhibition in London in 1887, and attendance at the meetings of the British Association in several years, established lasting relations with many English mineralogists. He was one of the most enthusiastic and successful of collectors, and found much of the enjoyment of life in the collection and study of minerals and meteorites.

THE *Pioneer Mail* of Allahabad is always to the front when the claims of science to a fuller recognition in India have to be urged. A leading article, in its issue of October 10, calls attention to the need for a better recognition of scientific research than at present exists there. "Buried in the archives of the Asiatic Society of Bengal," remarks our spirited contemporary, "in those of the kindred British societies, and in a few journals of the elect, is a mass of scientific literature relating to the Anglo-Indian Empire with which its Government professes to have no concern. Most of this literally priceless work has been done by Government officials in such leisure as they have been able to snatch from the daily turn at the Government mill. The Civil Service has been rich in amateur 'pandits,' but their fame is not echoed from the rocks of Simla, though it resounds in European halls of learning. In India such men were looked at askance by the Bureaucracy, and relegated to desert places. Years ago the State spoilt an excellent geologist by converting him into a Government gardener, and did the same for another by gazetting him an ornithologist. And all the while there is that great mine of palæontological wealth in the Sewaliks lying fallow since the days of Falconer—the far-away time of Cautley and the Ganges Canal. In a few cubic feet of worm-eaten Government reports are to be found the bald details of measurements which represent the Government knowledge of Indian archæology. No one has followed in the footsteps of Fergusson; his monumental work is a classic alongside with the unopen and dust-laden works of Todd in Rajasthan and many another amateur. Not very long ago Government nipped in the bud any inclination on the part of their little Geological Department to travel into regions other than those of purely economical geology. Now that General Cunningham is no more, that sole key to the history of ancient India—numismatics—would speedily rust and be lost were it not for the enthusiasm of an amateur, who is left to struggle along as best he can. A noble effort, but a lasting reflection, nevertheless, upon an enlightened Government."

EFFORTS are being made to obtain funds for the erection of a memorial to the memory of the late Joseph Thomson, the African explorer. Subscriptions may be sent to Mr. S. W.

Silver, 3 York Gate, Regent's Park, or to Mr. J. Scott Keltie, 1 Savile Row, Burlington Gardens.

A FEW particulars with reference to the Pasteur Institute, from the *British Medical Journal*, are of special interest at the present time. The receipts budget of the Institute is as follows :—The interest on £48,000, which is the amount that remains of the public subscription (about two-thirds of the sum subscribed, or £80,000, was spent on the ground bought for the Institute and in building). From £800 to £1200 was granted by the Minister of Agriculture in recognition of the service rendered by the anthrax vaccine, by the treatment of swine fever, and by the supply of tuberculin and mallein. A subvention is granted the Minister of Public Instruction to pay the salaries of such of the Institute staff as were formerly attached to Pasteur's laboratory. Certain profits are made by the sale of the anthrax vaccine, and others sold at a very low price to veterinary surgeons, and they realise for the Institute an income of £800. The fees paid by the pupils who attend the lectures of the Institute are also paid into the Institute treasury. Dr. Roux's antidiphtheric service is annexed to the Pasteur Institute, but has a distinct budget. This service is organised at Garches, on the estate given by the Government to M. Pasteur for the purpose of carrying on his researches on rabies. Its revenue is furnished by the interest on the sum realised by a public subscription, and by a Government grant amounting this year to £3200. The services at the Institute are as follows :—Practical services, consisting of inoculations, &c. ; the lectures in this service are given by Dr. Roux and Dr. Metchnikoff. The pupils are of two classes, "hearers" and "workers," who are allowed to work in the laboratories. The research laboratories are placed at the disposal of investigators, whose communications are published in the *Annales de l'Institut Pasteur*. The chiefs are—M. Duclaux for biological chemistry ; M. Grancher, M. Charrin, and M. Chantemesse for rabies ; M. Chamberland for microbic vaccinations and practical applications. There is a morphological laboratory under the direction of M. Metchnikoff, and a technical one under M. Roux. M. Nocard, professor at Alfort Veterinary School, directs a veterinary service annexed to the Institute. M. Duclaux is professor at the Faculté des Sciences. The course of lectures he previously gave at the Sorbonne are now held at the Pasteur Institute, where the Sorbonne pupils follow him. The Institute was founded in 1888, and retains its constitution and characteristics notwithstanding the death of Pasteur. His pupils will carry on the work.

THE late Mr. John Bell Sedgwick has bequeathed £300 to the Royal Institution in aid of the fund for the promotion of experimental research at low temperatures ; and Sir Frederick Abel has given £50 to the same fund.

THE Manchester Museum public lectures continue to attract large audiences. This year there are five courses, each consisting of three lectures ; and the first course was brought to a close on Saturday afternoon by an interesting discourse upon "Social Customs and Dwellings," the general subject being "The Elements of Anthropology," and the lecturer Prof. S. J. Hickson. The succeeding lectures are upon Mineralogy, by Dr. Burghardt ; Botany, by Prof. F. E. Weiss ; Geology, by Prof. Boyd Dawkins ; and Zoology, by Mr. W. E. Hoyle. There are now seven handbooks upon the various departments of the Museum, one of which—a handy guide to the whole of the cases—is sold for a penny. The aim of the Professors is to render the lectures educationally valuable, as well as interesting ; and the hands of the authorities will be strengthened by a recent grant from the Manchester Corporation of £400, which is to be annual.

THAT certain Hymenoptera and Homoptera secrete wax is well known, and a note by Dr. H. G. Knaggs, in the *Entomologist's Monthly Magazine* for November, indicates that this function can also be performed by Lepidoptera. An investigation of some cells of *Retinia resinana* proved them to contain a very appreciable amount of wax, which formed the lining of the cells. The nature of the lining was demonstrated by dissolving off the resin by immersion in cold rectified spirit, a fluid which appears to have little or no effect upon the wax, so that the latter was thereby exposed to view. "From this it seems to me," concludes Dr. Knaggs, "to be pretty clear that the larva is furnished with the power of secreting wax for the purpose of protecting itself from contact with the tenacious semi-liquid resin exuding from the wound in the fir bud ; otherwise, it would inevitably become involved in the sticky medium. Previously to this, however, I was aware that the imagines of certain Lepidoptera contained wax, though I had then formed no idea as to the part played by it in the economy of the insect's life."

GOLD-MINING is showing signs of revival in Victoria, as in many other countries. Forty years ago the colony was the foremost gold-producer in the world, throwing even California into the shade. Although, however, its output has shrunk from over 3,000,000 ozs. in 1856 to 673,000 ozs. last year, it has now, according to the *Annual Report of the Secretary for Mines*, again become a progressive quantity, and the product in 1894 was greater than that in any previous year since 1885. This was due to exceptional causes, the granting to the unemployed of free passes by railway from Melbourne to the various gold-fields having added 15,000 labourers to the number of prospectors and "fossickers." Quartz-mining was less actively pursued in 1894 than in 1893, and the whole gain came from alluvial deposits. Of these, as usual, the most important were the "deep leads" or gravels contained in the beds of Pliocene streams now buried beneath lava flows. In Victoria these gravels are almost exclusively reached by shafts, the deepest of which, at Bendigo, is now down 3122 feet. The Government geologist reports that some extensive systems of deep leads have been discovered and traced out by borings, one system in particular, on the northern side of the Great Dividing Range and to the westward of the meridian of Melbourne, having an aggregate length of forty miles of leads. To work this an enormous capital would be required, and it is proposed to make it a national undertaking, subsidised by the Government.

A VALUABLE paper on the new rubber industry in Lagos appears in the Kew *Bulletin* of Miscellaneous Information (No. 106, October), from which source the following facts were obtained. It is well known that in West Africa there are numerous plants yielding commercial rubber. The chief of these are species of the Apocynaceous genus *Landolphia*, consisting of climbing shrubs, with stems four to six inches in diameter dividing above into numerous branches, and supporting themselves on neighbouring trees. From these, and similar plants, a very important rubber industry was started at the Gold Coast by Sir Alfred Moloney, K.C.M.G., in 1882 ; and although previous to that year no rubber whatever was exported from that colony, it had attained in 1893 to the annual value of £200,000. This is a remarkable and striking instance of the creation of a new industry by official action, and it deserves to be recorded. In 1882, Sir Alfred Moloney pointed out the possibilities of a similar rubber industry in Lagos, and suggested "the adoption of measures having for their object the addition of one more to the industries of the colony." The result of this was not immediately apparent. But in 1894 the present Governor of Lagos, Sir Gilbert T. Carter, K.C.M.G., induced a party of natives from the Gold Coast, experienced in rubber collecting, to go to Lagos to develop this valuable and important industry. A new rubber-yielding tree, the native name of which is "Ire" or "Irai," was shortly afterwards discovered

to be abundantly distributed in the interior forests of the colony. The tree has been identified at Kew as *Kickxia africana*, Benth., and the history of its discovery, and the remarkable influence it has had upon the rubber industry, is full of interest, and illustrates the wonderfully rich resources of the forests of West Africa. The account also shows very clearly how these resources can be developed by judicious and intelligent action on the part of the Government.

A SPECIAL feature of the recent meeting of the British Association at Ipswich was the consideration given to agriculture and allied subjects. As already reported in our columns, a joint sitting of the Sections of Chemistry and Botany was held for the purpose of discussing the relations of agriculture to science. The discussion was opened by Prof. Warington, who read a paper on this subject. Mr. J. Hendrick, of the Glasgow Technical College, and Mr. M. J. R. Dunstan, the Director of Technical Education for Nottingham, also sent papers by way of contributions to the proceedings. One very good feature of this organised discussion was that copies of the opening paper had been freely circulated some time before the meeting, so that the speakers were prepared for the mode of treatment which Prof. Warington adopted. If this plan were more generally followed when discussions at joint sectional sittings were to be held, the value of such meetings would be greatly raised. In response to a widely-expressed desire, the three papers referred to, and a condensed report of the remarks made by the various speakers, have now been reprinted in pamphlet form, and can be had, at a trifling cost, from the Secretary of the British Association, Burlington House, or from the office of the *East Anglian Daily Times*, Carr Street, Ipswich. All who are interested in the agricultural question, from the educational or from the scientific side, will find much material for serious consideration in the various views expressed by a series of speakers of recognised authority.

DR. SIMPSON, Health Officer in Calcutta, in his annual report, refers at some length to Prof. Haffkine's anti-choleraic vaccinations, and expresses himself as very favourably impressed with the treatment, as far as can be judged at this early stage of the inquiry. Some interesting facts are quoted relative to the manner in which the progress of cholera in particular houses seemed to be arrested by inoculation. Thus, in one instance cholera attacked fatally one member of a household; two days later, eleven members of the family out of eighteen were inoculated. "It so happened," continues Dr. Simpson, "that cholera again breaking out in the house, attacking four persons, three of whom died, selected four of the seven not inoculated, while the eleven inoculated remained perfectly free." Again we read that two fatal cases of cholera and two of choleraic diarrhœa occurred in Katal Bagan Basti in a population grouped around the tanks. This outbreak led to the inoculation of 116 persons in the district out of about 200. Since the 116 cases were inoculated, nine more cases of cholera, of which seven were fatal, and one case of choleraic diarrhœa took place. All these ten cases of cholera occurred exclusively among the non-inoculated portion of the inhabitants, and not one of those treated with the vaccine were affected. Dr. Simpson recommends the Commissioners to give the system an extended trial, and he considers that such observations, if carried on in Calcutta on a large scale in its most affected parts during the next one or two years, would solve the question as to its efficacy. As regards the discomfort caused by the inoculations, he states that it is on the whole milder and of shorter duration than that of vaccination against small-pox. Two vaccines are used, one mild and the other strong, and for a complete vaccination two inoculations are necessary, first with the mild vaccine, which produces some pain at the seat of inoculation, or discomfort and fever for about one day; after a period of five days the second inoculation takes place with the stronger vaccine, which produces a similar form of malaise to that caused by the first inoculation. The harmlessness of the treatment has been established beyond question.

As one of the results of a long piece of work carried out in the botanical laboratory of Trinity College, Dublin, Mr. Henry H. Dixon believes that his preparations of the pollen-mother-cells of *Lilium longiflorum* before their first division show that origin of the double nuclear thread is not from the cleavage longitudinally of an originally single thread, but from the approximation of portions of the single thread, so that these portions come to lie more or less parallel to one another. When the thread breaks into the chromosomes the divisions affects both portions, so that each chromosome is composed of two more or less parallel pieces. These pieces may lie side by side, or may be fused together at one end while the other ends are somewhat parted asunder, or they may be bent in such a manner that they come to lie across one another in two or three places, or they may be fused together at both ends. As the chromosomes arrange themselves in the equator they become shorter and thicker, and they are so disposed that the plane of separation between their two parts lies vertically, and consequently they appear double when viewed from the polar aspect. At this stage, when seen from the equatorial plane, they have the appearance of short thick rods. Later on, horizontal fission takes place in each, beginning from the inner end. As this proceeds they assume the **T**-shape described by Belajeff. The daughter chromosomes have the **V**-shape as they leave the nuclear plate, having passed through stages similar to those described by this author. As they approach the poles each **V**-shaped chromosome cleaves transversely at the angle, and breaks into two short straight rods, so that at the poles there appear to be twice as many chromosomes as in the nuclear plate. Thus it appears probable, both from the origin of the two portions of the chromosomes forming the nuclear plate, and the subsequent division of the daughter chromosomes at the poles, that each chromosome of this mitosis corresponds to two chromosomes of previous nuclear divisions fused more or less completely end to end. The division following, to form the pollen-tetrads, was not observed in this plant, but it probably conforms in its details to the normal karyokinesis in plant cells, as in *Lilium Martagon* and *L. chalcedonicum* it was followed, and the normally-proportioned chomosomes undergoing longitudinal fission in the nuclear plate were observed.

A LONG paper on the working of iron and steel, by M. E. Demenge, appears in the *Revue Générale des Sciences* for October 15 and 30. The article is illustrated by twelve full-page plates, chiefly representing modern forging and rolling machinery.

IN *Botany Bulletin*, No. 11, of the Department of Agriculture, Brisbane, Mr. F. M. Bailey gives a complete list of the Freshwater Algæ of Queensland, including descriptions of several new species.

MR. G. MASSEE has reprinted from the *Annals of Botany* his paper on the "Spot-disease of Orchids," which shows that the disease is not of a parasitic nature, the initial cause being the presence of minute drops of water on the surface of the leaves at a time when the temperature is exceptionally low and the roots copiously supplied with water.

WE have received a further communication from Mr. Radcliffe, the inventor of the "38" puzzle (NATURE, No. 1352, p. 525) in which he shows how, by the sacrifice of his three extra symmetrical arrangements, the maximum number of 15 straight lines (all totalling to 38) can be obtained. He points out also some other symmetrical arrangements.

THE first edition of "Practical Physiology of Plants" (Cambridge University Press), by Mr. F. Darwin, F.R.S., and Mr. E. Hamilton Acton, was published a year ago. The work has been appreciated from the outset, and so great has been the demand for it that it has been out of print for a little time. A second edition has, however, just been published; but with our pleasure that the merits of the book have been recognised, must be mingled regret that the death of Mr. Acton should have prevented him from seeing its success.

THE forthcoming number of the *Physical Review* (November-December) will contain the following articles:—"Variation in Electric Conductivity of Metallic Wires in Different Dielectrics," by Fernando Sanford; "A Study of the Polarisation of the Light emitted by Incandescent Solid and Liquid Surfaces" (II.), by R. A. Millikan; "On Ternary Mixtures" (III.), by W. D. Bancroft; "On the Changes in Length produced in Iron Wires by Magnetisation," by L. T. More. Among the minor contributions will be: "The Limits of Pitch for the Human Voice," by W. Le Conte Stevens; "The New Physics Laboratory at Lille," by E. L. Nichols.

THE *Quarterly Journal* of the Geological Society (No. 204, November), just published, is illustrated by twelve plates. The contents of the number include a paper on the geology of Mount Ruwenzori and some adjoining regions of Equatorial Africa, by Mr. G. F. Scott Elliot and Dr. J. W. Gregory. Mr. A. Strahan explains overthrusts of Tertiary-beds in Dorset, and Mr. G. W. Lamplugh describes the "Crush-Conglomerates" of the Isle of Man, while Mr. W. W. Watts writes on the petrography of the same. The other authors and papers are: Messrs. W. Hill and A. J. Jukes-Brown, on the occurrence of Radiolaria in Chalk; and Dr. G. J. Hinde and Mr. H. Fox, on Radiolarian rocks in the Lower Culm Measures.

THE Meteorological Council have published the hourly means of the readings obtained from the self-recording instruments at the five observatories under their control, for the year 1891. The present volume contains the values for an additional observatory—Fort William, the low-level station of the Ben Nevis Observatory. An additional table has also been added to the series, containing hourly sunshine values, and in an appendix will be found the results of an hourly tabulation of the sunshine cards for the ten years 1881–90, for seven stations, illustrated by coloured plates. A summary of the hourly and seasonal variation of sunshine, based upon these values, was submitted to the Royal Meteorological Society, by Mr. R. H. Curtis, on June 19, a report of which appeared in our issue of the 27th of that month (p. 215).

IN connection with the recent jubilee celebrations at the Royal Agricultural College, Cirencester, which were attended by the Prince of Wales, as patron of the institution, a special effort was made to issue a number of the *Agricultural Students' Gazette* which should be worthy of the occasion. Several past professors of the college responded to the editor's call for co-operation, and accordingly we find articles on "Anbury, Club-root, or Finger-and-toe," by Mr. W. T. Thiselton-Dyer; on "The Rise and Progress of Veterinary Science in its Relation to Agriculture," by Prof. G. T. Brown; and on "Meadows and Pastures," by Dr. W. Fream. Old students are represented by Sir Jacob Wilson, who writes on the "Progress of Agricultural Education." Prof. Warington has a paper on "Organisms in Soil assimilating Nitrogen from the Atmosphere"; and amongst other subjects dealt with are the breeding of Shires, our meat supply, estate fences, curd making, chlorine in rain-water, and Samuel Hartlib and his "Legacie."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mrs. Jackson; three Red-backed Pelicans (*Pelecanus rufescens*) from East Africa, presented by Mr. F. E. C. Remington; two Verticillated Geckos (*Gecko verticillatus*) from Burmah, presented by Mr. H. Champion; a Common Boa (*Boa constrictor*) from South America, presented by Mr. F. J. Mitchell; a Whimbrel (*Numenius phæops*), European, presented by Messrs. Mason; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Brown Capuchin (*Cebus fatuellus*) from Guiana, deposited; two Black-tailed Flower-Birds (*Anthornis melanura*) from New Zealand, two Silver Pheasants (*Euplocamus nycthemerus*) from China, purchased; a White-tailed Gnu (*Connochætes gnu*, ♂) from South Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

STARS WITH BRIGHT AND DARK HYDROGEN LINES.—In his observations of the spectrum of the well-known bright line star γ Argus during 1893-94, Prof. Campbell noted the remarkable fact that whilst the red line of hydrogen was quite bright, the hydrogen lines in the violet were dark. The same peculiarity was also observed in the spectrum of η Tauri.

Since then Prof. Campbell has observed the spectra of all the available stars showing the F line bright in their spectra, and in some cases has secured successful photographs; from a consideration of the results obtained, he claims to have established the following points. (1) Some stars contain both bright and dark hydrogen lines. (2) The bright lines in such stars are those of greater wave-length, the dark lines are those of shorter wave-length. (3) The intensities of the bright lines decrease as we approach the violet. (4) The intensities of the dark lines increase as we go to the violet. (*Astrophysical Journal*, vol. ii. No. 3, p. 177).

In the case of γ Cassiopeiæ, Prof. Campbell finds the bright hydrogen lines to diminish very rapidly in intensity in the more refrangible part of the spectrum, and observes that they are situated within broad dark hydrogen lines; he does not, however, appear to have noticed the additional feature of the duplication of the bright lines in the spectrum of this star as photographed at Kensington (NATURE, vol. li. p. 425), although he records a similar appearance in the spectrum of φ Persei.

As to the explanation of the somewhat strange behaviour of the hydrogen lines, Prof. Campbell revives a suggestion due to Prof. Frost, namely, that the *selective* absorption of a star's atmosphere may be greater for the more refrangible rays, just as the *general* absorption of the sun's atmosphere is greater for such rays, the character of a spectrum being the resultant of radiation and absorption phenomena.

As first pointed out in connection with the meteoritic hypotheses, these stars represent a very early stage in sidereal evolution, and we note that Prof. Campbell adopts this view. He finds also that the variations of spectrum in passing from one star to another indicate that many steps in the evolutionary process are represented.

PARALLAXES OF STELLAR SYSTEMS.—The possibility of determining the parallax of a binary star, and hence the dimensions and mass of the system, by a spectroscopic observation of the relative velocity in the line of sight, was first pointed out by Fox Talbot in 1871, but the suggestion has not yet borne fruit. Some hesitation in taking up this interesting piece of work has no doubt been due to the smallness of the velocity to be measured in most cases; but now that such a high degree of accuracy is attainable, there is no longer any reason to suppose the method impracticable. A very simple way of computing the parallax from an observed velocity in the line of sight was introduced by Dr. Rambaut a few years ago, a knowledge of the orbital elements being assumed (*Monthly Notices*, vol. l. p. 302). This paper seemed to supply all that was needful in the way of facilitating the necessary computations; but Dr. See has recently treated the subject somewhat differently (*Ast. Nach.*, No. 3314). The hodograph of an ellipse being a circle, the velocity at any point in the ellipse is represented by the radius vector of the hodograph which is parallel to the tangent to the orbit at the point in question. The radius of the hodograph can be determined from the spectroscopically observed velocity, and the value of the velocity in the line of sight can then be predicted

for any instant whatever. From the orbital velocity it is easy to deduce the length of the semi-axis major of the orbit, and the parallax is equal to the semi-axis major in seconds of arc, divided by the length of the same when expressed in astronomical units. The sum of the masses follows from the ordinary application of Kepler's third law. Dr. See lays special stress upon the importance of these investigations being taken up practically, as they will furnish us with "an absolute parallax exact to the highest degree," and will also enable us to apply a rigorous test of the universality of the law of gravitation. It is known already, from micrometrical measures, that Kepler's second law holds good for binary stars, and therefore that the force is central; but it remains to be shown that the principal star is in the focus of the real ellipse.

THE SOLAR PARALLAX.—Among the various methods suggested as suitable for the determination of the solar parallax, that afforded by the parallactic inequality in the motion of the moon deservedly takes a high place. The reason is that in this particular term the parallax of the sun is multiplied by a coefficient which increases the quantity to be determined in the approximate ratio of 1 : 15, so that an error of a tenth of a second in the inequality would not produce an error of one-hundredth in the parallax sought. But in deriving the solar parallax it is necessarily assumed, that the relation between these quantities is accurately given by theory. Unfortunately there has been a discrepancy between the coefficients derived by Hansen and Delaunay, and the accepted explanation has not been the correct one. In order to ensure identity between Hansen and Delaunay it was necessary to suppose than an error existed in the highest term computed by Delaunay, and that the deviation of the remaining terms from the general character of the series did not exist. Recent work by Mr. Hill and Prof. Brown has, however, confirmed the accuracy of Delaunay's theory so far as this particular term is concerned, though it leaves a general doubt on the legitimacy of neglecting the higher terms in some of the series in other parts of the theory. Prof. Newcomb points out (*Astronom. Jour.* No. 356) that this more recent discussion of Messrs. Hill and Brown demands an increase on the theoretical value of Hansen, on which he had previously relied, of 0″·30, and consequently a diminution in the solar parallax of 0″·021 giving the corrected value of $\pi = 8''{\cdot}773$.

THE EPPING FOREST MUSEUM AT CHINGFORD.

THE opening of this museum, which we announced in our last week's issue as having been fixed for Saturday, November 2, was in every respect an interesting ceremony, and marks a period in the history of the Essex Field Club, of which this active society may well feel proud. Two or three years after the foundation of the Club in 1880, an informal meeting was held at the residence of Mr. E. N. Buxton, with a view to starting such a local collection, but the Conservators at that time had not long been in charge of the Forest, and they did not see their way to giving house-room for the museum in the old lodge known as "Queen Elizabeth's." The founders of the Club, however, have never lost sight of the desirability of having such a collection in the Forest district, and in February 1894, a special meeting of local residents and others was convened, and a local sub-committee formed for the purpose of forwarding the scheme. A subscription list was opened, and a sufficient sum raised to warrant another application to the Conservators for the use of Queen Elizabeth's Lodge. This was granted, and the Banqueting Room, which from time immemorial has been unoccupied and devoid of fittings, has now undergone transformation into a museum, which was declared open to the public as a part of Saturday's proceedings. The arrangement of the collections, illustrating the natural history, geology, archæology, and topography of the Forest, has been entirely carried out by Mr. William Cole, the Hon. Secretary of the Club, aided by his brothers and a few zealous workers who gave their co-operation, notably Messrs. W. Crouch, I. Chalkley Gould, A. Greenhill, and others. On Saturday afternoon a very representative gathering of scientific men took place at Chingford, to assist at the opening ceremony. The members and guests, comprising among the former Sir William Flower, Mr. Edward North Buxton, Profs. R. Meldola and G. S. Boulger, Mr. J. E. Harting, &c., and among the latter a large number of the Epping Forest Committee of the Corporation of London, were received by the President of the Club, Mr. David Howard, in a room adjoining the museum. After a few introductory remarks by the President, Sir William Flower addressed the meeting on the general subject of local museums and the advantages to be derived from their establishment. Mr. Deputy Halse, the Chairman of the Epping Forest Committee, then expressed, on behalf of the Corporation, the satisfaction which they all felt in being associated with the Essex Field Club in the movement, and declared that from Monday, the 4th, the collections would be available for public inspection. The party then proceeded to view the museum, and great satisfaction was expressed at the large amount of material which had been brought together in a comparatively short time and with very modest financial means. Mr. Greenhill's collection of flint implements from the valley of the Lea, Mr. T. Hay Wilson's set of drift rock materials from the local glacial gravels, Mr. Crouch's shells of the Dengey Hundred, the cabinets of Forest flowering plants, fungi and insects, and the interesting set of relics found during the Club's explorations of the Forest earthworks, were all much admired. A pamphlet by Mr. Chalkley Gould, being one of a proposed series of museum handbooks, was distributed at the meeting. The author in this pamphlet gives a description of the Romano-British station at Chigwell in illustration of the specimens which he has contributed to the museum. After the inspection the party assembled for tea at the Royal Forest Hotel, some eighty or ninety members and visitors being present. At a meeting of the Club, held after tea, the President moved a vote of thanks to Mr. William Cole and his coadjutors for the large amount of work which they had voluntarily done on behalf of the museum. This was warmly seconded by the Rev. A. F. Russell, the rector of Chingford, who is chairman of the local sub-committee. Mr. Cole having acknowledged the vote of thanks, Mr. A. Smith Woodward (of the British Museum) then gave a short address, in the course of which he pointed out the essential requirements that the museum should fulfil in order to be of real use, and commented most favourably upon the arrangement of the collections, their contents, and their mode of display. Sir William Flower expressed his concurrence with Mr. Woodward's remarks, and made some further observations and suggestions, especially dwelling upon the importance of taking steps to insure the permanence of the museum when those who had laboured so well for its foundation were no longer able to carry on the work. In the course of his remarks he paid a high tribute to the general work of the Essex Field Club, of which he had been an honorary member almost from the time of its foundation. Prof. Meldola, in proposing a vote of thanks to Mr. Deputy Halse, pointed out that the element of permanence to which Sir William Flower had alluded was most likely to accrue from their association with the Epping Forest Committee. This vote having been seconded by Mr. E. N. Buxton, and replied to by Mr. Halse, Mr. Harting made some remarks on the danger of encouraging promiscuous "collecting" by schoolboys, and the proceedings terminated. Favoured by an exceptionally brilliant autumnal afternoon, the meeting was a distinct success, and must have given great satisfaction to its promoters. The museum is necessarily small, but a good beginning has been made, and the time may be looked forward to when increased accommodation will be required. The feature which most strongly commends it to students of natural science, and lovers of the Forest generally, is the purely local character of the collections. No more appropriate use of Queen Elizabeth's Lodge could possibly have been made, and the Corporation of London have done wisely in allowing the Essex Field Club to found an institution which, however small and unpretentious, is, even as at present appointed, a distinct boon to all frequenters of the Epping Forest district.

CONCENTRATION OF GOLD ORES.[1]

WHEN gold mining is a new industry in any country, the methods of extraction are often somewhat rough and ready. With great quantities of rich ore waiting for treatment or easily obtainable, the mill-man is usually intent on obtaining the greatest possible quantity of bullion in a short time, rather than on establishing a good system of reduction, which in the

[1] "Report on the Loss of Gold in the Reduction of Auriferous Veinstone in Victoria." By Henry Rosales. (Issued by the Department of Mines, Melbourne, 1895.)

long run would extract the maximum percentage of gold per ton at the minimum cost. It matters little to him how much gold runs off in the tailings into the nearest stream, so long as enough is extracted to pay expenses and yield a handsome profit. When, however, the industry becomes firmly established, the aspect of affairs is changed. The richer mines can afford to spend something in endeavouring to improve their practice; the poorer ones have their very existence threatened by the loss of 30 or 40 per cent. of the gold, which has been raised from a great depth, only to be left on the dumping ground.

This stage has long been reached in the older gold fields of Australia, such as those in Victoria, where the industry has always been carefully nursed by the Government. One of the latest proofs of the solicitude of the Victorian Department of Mines is the issue of this report of Mr. Rosales, the veteran expert on concentration, who gained a Government prize for an essay on the subject as long ago as the year 1861. The report deals with the concentration of tailings from the stamp battery, and although it is specially applicable to Victoria, nevertheless it contains much information and many suggestions which deserve careful study by metallurgists in all parts of the world, and may be particularly valuable to the workers in South Africa.

In Victoria, as in many other countries, the majority of the gold ores found are "free-milling," yielding a fair percentage of their gold when amalgamated with mercury. The usual method of treatment is to crush the ore in a stamp-battery, a little mercury being added in the mortars, and to pass the pulp over amalgamated copper plates, by which most of the free gold is retained. The "battery sands," still containing a little free gold and a varying percentage of auriferous sulphides of the heavy metals, are then treated by various machines, such as canvas tables, vanners, percussion tables, blanket and wooden strakes, and revolving buddles, with a view to separate the heavy particles in which the gold is contained from the lighter worthless gangue. The concentrates are treated by grinding to impalpable pulp with mercury in iron pans, by chlorination or by smelting, according to the nature of the sulphides and to the other conditions.

The tailings from the orthodox concentrating machines would be allowed to run to waste if it were not that, on almost every mine in Victoria, they are compelled to run the gauntlet of the simple contrivances of a few Chinamen, who pay tribute to the mine-owner for the privilege of taking his leavings, and who extract enough gold to provide themselves with a living. Nevertheless it was stated in 1889, on the very high authority of the late Government analyst, Mr. J. Cosmo Newbery, that the tailings of the quartz-mining districts, even after passing the Chinese tables, contained in general from two to two and a half dwts. of gold per ton—some 15 per cent. of the amount originally contained in the ore. The gold thus lost is estimated as being of the value of over £350,000 in the year 1894, and a similar state of things is unfortunately only too prevalent in other countries.

Experts are agreed that it is the methods of concentration which are chiefly answerable for the continuance of this unsatisfactory state of things, not so much because the machines now at the disposal of the metallurgist are defective, as that in many cases they are set to do work for which they are inappropriate, although capable of dealing effectively with certain classes of material. In particular, the neglect on the part of metallurgists to classify the crushed ore according to size has been fatal to good concentration in a countless number of cases, and this mistake has not yet been generally rectified.

Let us suppose that a gold ore has been crushed so as to pass through a screen equivalent to a wire-sieve with thirty holes to the linear inch. The particles of ore are of all sizes, ranging from those which can just pass through the screen down to perfectly impalpable powder. From 20 to 50 per cent. would easily pass through a 100-mesh sieve, and a part of the ore, the "slimes," is so finely divided that it settles in still water with great difficulty. In spite of this, the whole mass, without any classification, is perhaps, after treatment with blankets, hurried over some one type of concentrator favoured by the manager, and the tailings allowed to escape without further treatment.

For example, a percussion table with "end-blow" is used, and the coarser particles of pyrites are readily separated from the remainder of the ore by its action. It usually happens, however, that the valuable sulphides, being softer than the quartz and other constituents of the gangue, are in the main more finely pulverised than the latter, so that the slimes are the richest parts of the ore, and these, under the circumstances, will almost all escape. Thus at the Johnson's Reef Mine, Eaglehurst, it was found that the "slimes," though constituting only 3 per cent. of the pulp, contained 21 per cent. of the gold, while 44 per cent. of the pulp, which was retained on a 60-mesh sieve, consisted mainly of quartz grains, and was absolutely worthless.

Or, in the alternative, the battery sands may be sent directly to some travelling belt table, such as the Frue vanner—a machine capable of doing splendid work in saving rich slimes—with the result that the coarser particles, valueless in themselves, interfere with its efficiency. Mr. Rosales cites the case of a mine at Ballarat, where the costly Frue vanners, which had been set to treat unclassified battery sands, were discarded in favour of the cheaper percussion tables, the fact being that neither concentrator could be expected to save the pyrites properly, the vanner being no more fit to treat coarse material than the percussion table is adapted to concentrate slimes. It would have been better to use the two machines successively on the same material, although even then, in the absence of classification, losses could not have been prevented.

Mr. Rosales has not been content to criticise, but has added a sketch of a complete system of concentration, which, with modifications, would be applicable to almost every gold ore likely to be met with. The keynote of the system is classification, and he can hardly be accused of laying too much stress on it, seeing that it has been neglected more generally than any other consideration in the past. He favours hydraulic classifiers (inverted pyramidal or pointed boxes of various forms) for separating the slimes from the sand; but, on the other hand, he considers that the division of the sand itself into two or three classes, according to the size of the grains, is best effected by revolving screens or trommels.

This view will undoubtedly be called in question. It is rare that a finer screen than one containing twenty holes to the linear inch is fitted to these machines, and although 60-mesh screens have been employed, the smallness of the capacity of trommels supplied with such fine sieves, and the great cost of repairs caused by their rapid wear, seem to render it unlikely that they will ever come into wide use. In revolving screens the effective surface operating at any one time is only a few inches wide, and, if they were fitted with 100-mesh sieves, it is to be feared that continuous clogging would reduce their capacity almost to the proverbial teaspoonful. There seems no adequate reason why the cheap, handy, rapidly-acting pointed boxes should be passed over, and if Mr. Rosales would press these, instead of the trommels, on Australian mill-men, he would perhaps find a more ready acceptance of his suggestions. It is true that when pointed boxes are used, the particles of ore in each class are "equivalents" (*i.e.* those falling at an equal rate in water), and not equal in size, particles of high density being left mixed with somewhat larger ones of lower density, but the classification is usually sufficient for the purpose.

For the rest, Mr. Rosales seems to lay more stress on efficiency than on cheapness. When, as in his complete system, nearly twenty different machines, without counting duplicates, are at work, each with a different purpose, in removing the auriferous sulphides from one kind of ore, the loss of gold may be reduced to little or nothing, but it is evident that the extra amount saved is not all clear gain. An additional percentage of gold may often be obtained at a loss, even by an automatic machine if it is costly to buy and to keep in repair.

No sudden drastic changes, however, are proposed by Mr. Rosales. The losses of gold in Victoria and elsewhere are undoubted, and until it has been shown that they cannot be profitably reduced, no shirking of the matter is admissible. Tests on each mine by sieving and assaying in the laboratory (which, alas! too often is non-existent) can alone show in what direction the practice may be improved, and, if proper attention were paid to the slimes only, many gold mines would have a much brighter outlook than at present.

In conclusion, a word may be said in protest against the unscientific and misleading Australian (and English) method of reporting assays of gold ores. The actual weight of gold extracted from the sample of ore is seldom recorded, and the probable error is quite undiscoverable. An observed weighing of 0·001 grain may be reported as 15 grains per ton, or may appear as two, three, or more times this amount. In every case the unit in the report is much smaller than that used for the observation. What analytical chemist would be guilty of such practices in his other work?

T. K. ROSE.

A DESTRUCTIVE PLANT PARASITE.[1]

A DISEASE of vine-leaves, characterised by the presence of brown or blackish blotches, which frequently spread over the entire surface of the leaf, has been known in European and American vine-growing districts under various provincial names for some years. This disease, known in France as *brunissure*, was investigated by Viala and Sauvageau, who concluded that it was due to the presence of a parasitic organism to which the name *Plasmodiophora vitis* was given. Prof. Debray's researches show that brunissure is far more generally distributed than was hitherto suspected, having been detected by this observer in plants belonging to forty-two natural orders. In like manner, the leaf is not the part most frequently attacked, as supposed by Viala, but root, branch, flower, and in fact every portion of a plant is liable to attack. Owing to the absence of spore-formation, zoospores, nuclei, and slender pseudopodia, coupled with the fact that, although a parasite, there is no trace of malformation of the host, Debray considers that the organism under consideration cannot be included in the Plasmodiophoræ, nor in any other recognised family, and proposes for its reception a new family, Pseudocommidæ, and a new genus, *Pseudocommis*, allied to Vampyrellæ and Myxomyçetæ. The supposed organism when in plant cells is difficult to distinguish from the protoplasm of the cell, and more especially the nucleus; it is, however, more refringent, and usually remains intact after the protoplasm has been destroyed by the use of eau de Javelle. Iodine-green and methylene-blue give a green and blue stain respectively; the most certain reaction, however, is said to be chlor-iodide of zinc, which gives a yellow or brown colouration to the plasmodia. The organism is met with under various forms in the cells of the host, never occurring in the intercellular spaces; the plasmodium may be intimately mixed with, and almost indistinguishable from the protoplasm of the cell, or distinct from the cell-contents and densely vacuolate, or finally, in assuming a spherical form, perfectly homogeneous, or with a few spherical vacuoles. Under certain conditions the plasmodium travels from the interior of the cells of the leaf or other part of the plant to the surface, where it appears as a slimy or gummy secretion, and by this means passes on to other parts of the plant which are attacked. Sometimes the external plasmodium becomes hardened into wax-like masses or cysts, which are considered to represent a resting-stage. The appearance and spread of the disease is much influenced by meteorological conditions, a sudden chill favouring its development. No preventive based on experiment is given, but it is suggested that badly diseased parts should be removed, and the external migration of the parasite checked by a dusting of powdered lime.

If Debray's observations prove to be correct, we have in *Pseudocommis* the most universally diffused and destructive of plant parasites hitherto known.

SCIENCE IN THE MAGAZINES.

EVERY individual, as Prof. Milnes Marshall used to say, climbs up his own genealogical tree. Embryology shows how human lineaments are developed from a widely typical animal form, and evidences of the same relationship can be obtained from the study of the infant after birth. In the *Fortnightly*, Prof. Sully pleads for such study. "Ours is a scientific age," remarks he, "and science has cast its inquisitive eye on the infant. We want to know what happens in the first all-decisive two or three years of human life, by what steps exactly the wee amorphous thing takes shape and bulk, both physically and mentally. And we can now speak of the beginning of a careful and methodical investigation of child nature by men trained in scientific observation. This line of inquiry, started by physicians, as the German Sigismund, in connection with their special professional aims, has been carried on by a number of fathers and others having access to the infant, among whom it may be enough to name Darwin and Preyer." The biologist is able to use the physical development of a child to show man's kinship to the lower animal world, and the development of an infant's mind indicates to the psychologist how the mental history of the race has been evolved. It does not need a very acute observer to see the intellectual and moral resemblances between the lowest existing races of mankind and children. Several anthropologists have studied this phase of child-life, and have found it full of interest. The difficulty is to get systematic and scientific observations of children. Prof. Sully shows that the work is worth doing, and indicates some of the lines of study to be followed; all that is needed is methodical and trustworthy registration of the successive stages in the child's development.

A second article in the *Fortnightly* is a reply by Prof. Karl Pearson to an article in the September number of the *Review*, where Dr. St. George Mivart attempted to describe the limits of scientific knowledge and inquiry, and to show that many teachers of science were dogmatic, or "denominational," as he called it. Two other articles in which some of our readers may find interest are "Brahminism and the Foundations of Belief," by Vamadeo Shastri, and "Vegetarianism," by Mr. T. P. Smith.

An article on Pasteur, contributed by Profs. Patrick Geddes and J. A. Thomson to the *Contemporary*, is a readable and fairly full statement of his personal life and scientific work. The authors thus sum up Pasteur's legacy to the world: "There is the impulse which he gave, after the successful organisation of his own Institute, to the establishment in other countries of similar laboratories of preventive medicine, and, one may also say, of experimental evolution. There is his educative work at Strassburg and Lille, at the École Normale and the Sorbonne, and, above all, in the smaller yet world-wide circle of his immediate disciples. To general biology his chief contribution has been the demonstration of the part which bacteria play, not only in pathological and physiological processes, but in the wider drama of evolution. To the chemist he has given a new theory of fermentation; to the physician, many a suggestive lesson in the etiology of diseases; and a series of bold experiments in preventive and curative inoculation, of which Roux's treatment of diphtheria, and Prof. Fraser's new remedy for snake-bites, are examples at present before the public; to the surgeon, a stable foundation, as Lister acknowledged, for antiseptic treatment; to the hygienist, a multitude of practical suggestions concerning water-supply and drainage, disinfection and burial. On brewer, distiller, and wine-maker he has forced the microscope and its results; and he has shown both agriculturist and stock-breeder how some, at least, of their many more than ten plagues may be either averted or alleviated." In the same *Review* Mr. Herbert Spencer traces the development of the judge and lawyer, and points out the relations between the priestly and judicial functions. There is also a forcible and philosophical reply by Father Tyrrell to Miss Cobbe's utterances in the October number. We content ourselves with giving two of the thirteen points upon which Father Tyrrell bases his position; they are: (1) as animals vary in sensibility, our duties concerning them vary also; (2) in the abstract, vivisection is not only permissible but laudable in certain conditions. Whether these conditions are or can be realised is a matter of opinion. He concludes: "Whatever one may think of the old-fashioned psychology on which this system rests, no one can deny that it is at least coherent and in keeping with the common sense of the best part of mankind, and that it offers a full and firm basis for a humane and reasonable treatment of animals, without entailing any of those hopeless problems which Miss Cobbe has to encounter in the application of her system."

A fine portrait of the late Prof. von Helmboltz, taken on the day of his last appearance in the lecture room, by C. Riborg Mann, appears in *Scribner*, accompanied by a brief summary of his leading contributions to science. The circumstances under which the photograph was taken are thus stated by the author: "At the close of his lecture on Saturday, July 7, 1894, Prof. von Helmholtz, at my earnest request, remained a few minutes in the class room and allowed me to photograph him. He stands as he was accustomed to appear before his students, the formulas as he had just written them remaining on the blackboard as a suitable background. By a strange working of fate, that was the last day on which he lectured, excepting one, when he gave some matter supplementary to this occasion; and this is his last photograph." A paper entitled "The Logic of Mental Telegraphy," contributed by Prof. Joseph Jastrow to the same magazine, should be taken to heart by a gullible public. Nothing is said about the attempted experimental tests of thought-transference, which may be worth investigation, but it is shown that coincidences will account for the possibilities of mental telegraphy believed in by the popular mind.

A few reminiscences of Huxley's habits and work at the

[1] "La Brunissure chez les végétaux," *Revue de Viticulture*, 5 Rue Gay-Lussac.

Royal College of Science, South Kensington, are contributed by Prof. G. B. Howes to the October number of the College's *Magazine*, and are accompanied by an excellent portrait of Huxley. This article throws some interesting side-lights upon Huxley's great personality, especially with reference to his bearing towards his students and subordinates.

A passing allusion will suffice for the remaining articles of scientific interest in the magazines that have reached us. *Longman's* contains a popular description of the making of kelp, by Mr. D. J. Robertson, and also a paper on the disappearance of gulls from "Pallinsburn Gull Pond," by Mr. P. Anderson Graham. In *Good Words* Sir Robert Ball writes on "Halley," Sir Herbert Maxwell, Bart., pleads for the preservation of the "Fowls of the Air," and the Marquis of Ormonde describes a short cruise to Norway and Spitzbergen. The *Sunday Magazine* contains the concluding paper by "Eha," on "Voices of the Indian Night." *Chambers's Journal* has, among the subjects of its popular articles: "The Coal of the World," "Migrations of Fish," "Some Modern Uses of Glass," and "A Bundle of Paradoxes." The *Strand Magazine* has a number of graphical representations of statistics referring to the coinage productions of the Royal Mint, by Mr. J. Holt Schooling. The *National* contains a brief appreciative note on Pasteur's work. In addition to the magazines mentioned, we have received the *Quarterly Review*, *Century Magazine*, *Humanitarian* (in which occurs a paper by Prof. W. F. Barrett, on "Dynamic Thought"), and the *English Illustrated Magazine*.

THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM.[1]

SUMMARY OF THE CHIEF SCIENTIFIC RESULTS OBTAINED DURING THE YEAR 1894.

I. *England and Wales.*

THE survey of the Lower Silurian rocks of the Isle of Man has been continued by Mr. G. W. Lamplugh, who finds that the Skiddaw slates of this island, although they possess much lithological variation, are essentially the same mass throughout and are hardly likely to disclose any base to the series. Nor has it been possible to trace any sub-divisions, equivalent to those in the Lower Silurian rocks elsewhere, owing to the absence of fossils.

Reference was made in the previous Report (1893) to certain conglomerates or breccias which it was suggested may have been produced by the breaking up of sandy slates and grits under intense shear strain. These remarkable rocks have been found during the past year to attain an importance altogether unsuspected. Mr. Lamplugh has traced them in definite bands following the prevailing strike of the Skiddaw slates, and generally intercalated between an argillaceous and a more or less arenaceous group of strata. He has found one band to run continuously for eight miles, and thereafter, somewhat less clearly, for four miles further.

In the area of South Wales considerable tracts of Old Red Sandstone have been mapped during the past year by Mr. J. R. Dakyns and Mr. A. Strahan; and so far the following local subdivisions have been recognised:—

(3) Grey quartz-grits and conglomerates with some red sandstones. This group forms the uppermost of the whole series.

(2) Massive red sandstones with some conglomerates and a few red shales, as well as occasional grey sandstones and thin limestones (cornstones).

(1) Red and variegated marls with bands of soft red sandstone and thin limestones (cornstones).

These three sub-divisions pass into each other.

In Devonshire and Cornwall the re-survey of the Devonian formation and associated igneous rocks has been continued by Mr. Ussher, who has recognised that Upper Devonian strata are largely developed in the southern parts of these counties. Thus they are found skirting the Dartmoor granite, from Kingsbridge Road to Shaugh Prior, not far from Plymouth. In the Plymouth district, they consist of slates with local volcanic materials and a mass of porphyritic diabase at Ford, near Devonport. As they range into Cornwall, they present some specially interesting features. Besides retaining their evidence of contemporaneous volcanic action, they have yielded fossils which prove their stratigraphical position and allow of their being correlated with the Upper Devonian group of other regions.

The progress of mining, since first the maps of the coal-fields were published, has been so great that many of these maps have become more or less obsolete. It is therefore highly desirable, from an industrial and national point of view, that the surveys of our mineral fields should be revised, in order to place within reach of the mining community, and of the public generally, an accurate representation of the various coal-fields on which so much of the material prosperity of the country depends.

The re-survey of the great coal-field of South Wales has now been in progress for three years, and during the past year that of the North Staffordshire and Leicestershire fields has been begun.

During last summer certain improvements were made in the mapping of the Whitehaven district, particularly in regard to the boundaries between the formations and the positions of the faults. One of the most interesting points in this re-examination, made by Mr. A. Strahan, was the proof obtained of the existence of two distinct systems of faults, the one older than the Permian period and running from south-west to north-east, the other later than that period and trending from south-east to north-west. This fact had been previously insisted upon by Mr. J. D. Kendall, to whom the Survey is greatly indebted for his generous courtesy in supplying all the information which he had amassed during a residence of many years in the district as a mining engineer.

The chief work of the past year among the Cretaceous formations has been the tracing, by Mr. Jukes-Browne, of the various sub-divisions of the Chalk over tracts of the southern counties where they had not been previously mapped. Apart from its scientific interest this re-survey of the Chalk is of great economic importance. The maps will henceforth show at a glance the distribution of the various members of the Chalk, and thus will furnish accurate information for the guidance of those who have to sink wells or deal with the water-supply and drainage of the wide chalk-districts of the south of England.

Mr. Whitaker and Mr. Reid have continued the revision of the Tertiary strata in the Hampshire Basin.

During the past year the survey of the Superficial Deposits for the construction of an agronomic map of the country has made good progress in the midland and southern counties, and much new information has been obtained with regard to the extent of the drifts in Monmouthshire and South Wales.

In the valleys that intersect the South Wales coal-field, and chiefly end in the broad dip-slopes of the northern outcrop of Millstone Grit, much boulder-clay as well as gravel has been noticed by Mr. Gibson. It is almost entirely of local origin. That these uplands were overspread with ice is shown by the occurrence of glacial striæ on the Millstone Grit at a height of about 1500 feet above the sea. Further proof that the ice must have existed in considerable mass has been obtained in the excavations of some new waterworks at Nant-y-bwch, where a hill of sandstone upwards of 200 yards in length has been found to be a transported mass. Though its bedding is only slightly disturbed, yet the whole mass has been ascertained to lie upon boulder-clay, and must therefore be regarded as a huge boulder.

In the Isle of Man, Mr. Lamplugh has observed that the marked distinction referred to in the previous Report, between the insular drift of the hills and the extra-insular drift of the low ground still continues. The relative distribution of these drifts seems to prove that both are of truly glacial origin. Most of the deeper glens in the Isle of Man were probably filled with local glaciers before the coming of the great south-flowing ice-sheet which afterwards overrode the island up to its highest summits. As shown by numerous striæ observed on the Skiddaw slates, the general march of the ice during the height of the glaciation seems to have been from some point west of north, instead of east of north, as usually stated. A bed of fine warp or silt in the glacial series of Kirk Michael may prove to be of some economic value. It has been locally used in past time as a fuller's earth, and an effort is now about to be made to introduce it to a wider market for the same purpose.

II. *Scotland.*

As announced in the previous Report, all the tracts of Lewisian gneiss on the mainland, from Cape Wrath to the Kyles of Skye, have been mapped, but there are many displaced tracts or slices of that formation which lie to the east of the great line of com-

[1] Extracted from "Annual Report of the Geological Survey by Sir Archibald Geikie, D.Sc., LL.D., F.R.S., Director General," published in the *Report of the Science and Art Department* for the year 1894.

plication, and have undergone more or less deformation in the course of the gigantic earth-movements which placed them in their present positions. So far as at present known, no unmoved tracts of the oldest gneiss are to be looked for in the regions of Ross-shire and Inverness-shire yet to be mapped, but there may be many more or less recognisable disrupted masses among the crystalline schists of that region.

The only area where any of the Lewisian gneiss was mapped last year, on the western or undisturbed side of the great line of displacement, lay in the Island Raasay, where Mr. Teall completed the survey of these oldest rocks. As far as the mapping of the north-west Highlands has advanced, the various crystalline rocks older than the Torridon sandstone, and comprised under the general designation of Lewisian gneiss, may be divided into five distinct groups. (1) What has been termed the "fundamental complex," consisting of various more or less banded and foliated rocks which form together the oldest, and chief part of the gneiss. (2) Highly basic dykes cutting the fundamental complex. (3) Dykes and sills of dolerite, epidiorite, and hornblende-schist. (4) A few dykes of peculiar composition. (5) Gneissose granite, and pegmatite.

Mr. Teall has devoted himself, both in the field and with the microscope in the office, to the patient study of these rocks, and he has at last been able to formulate his views regarding the nature and composition of the various rocks comprised within the first of these sub-divisions, the "fundamental complex." He reports to me that over the greater portion of the area between Skye and Cape Wrath the rocks of the "fundamental complex" have decided affinities, both as regards chemical and mineralogical composition with plutonic igneous products, and his detailed Report, so far as these rocks are concerned, is now fairly complete. They are essentially composed of olivine, hypersthene, augite (including diallage), hornblende, biotite, plagioclase, orthoclase, microcline, and quartz; and the laws of paragenesis are the same as those which govern the composition of peridotites, gabbros, diorites, and granites. It is rare to find any one petrographical type persistent over a large area. Variations in the relative proportions of the different constituents are almost everywhere recognisable, and these variations may be either abrupt or gradual. One general law appears to have been established as far as the fundamental complex is concerned. Whenever the relative ages of two distinct petrographical types can be clearly ascertained, the more basic is older than the more acid.

In classifying the rocks, either with reference to structure or composition, difficulties arise in consequence of transitions in various directions. Many schemes have been proposed; and the following one, based primarily on mineralogical composition, and to a subordinate extent on structure, has been devised by Mr. Teall for descriptive purposes. Theoretical considerations have been excluded, and it is hoped that whatever view may be finally adopted, the broad general facts will be found to have been correctly recorded :—

I. Rocks composed of ferro-magnesian minerals without felspar or quartz.

(1) Pyroxenites.
Locality. Scourie, Drumbeg.
(2) Hornblendites.
Same localities as pyroxenites, and also as lumps in the gneiss of many other localities.

II. Rocks in which pyroxenes are the dominating ferro-magnesian constituents. Felspar always present, and in some cases quartz.

(*A*) Without quartz.
(*a*) Hypersthene-augite-rocks.
(1) With garnet (pyroxene-granulites).
Locality. Scourie.
(2) Without garnet (rocks of the Baltimore-Gabbro type).
Locality. Scourie, Gruinard.
(*b*) Augite-rocks. Gabbros in structure and composition, but forming part of the fundamental complex, and often associated with quartz-bearing rocks of a similar character.
Locality. Kyle Sku, Loch Inver.

(*B*) With quartz.
(1) Augite gneiss.
Locality. Kyle Sku, Loch Inver.

III. Rocks in which hornblende is the dominating ferro-magnesian constituent.

(*A*) Without quartz, or containing it only in small quantity. Rocks basic in composition.
(*a*) Rocks massive or only slightly foliated (Amphibolites).
(1) Epidote-amphibolite.
Locality. Near Stoer.
(2) Zoisite-amphibolite.
Locality. Sangomore Bay.
(3) Garnet-amphibolite.
Locality. Between Scourie and Laxford Bridge.
(*b*) Rocks foliated :—
Hornblende schist.
Locality. Between Laxford Bridge and Durness, also at Shieldag, Rona, and many other localities.
Note.—Many of the hornblende-schists found in the Lewisian gneiss are foliated dykes.

(*B*) With quartz. Rocks intermediate or acid in composition.
(1) Rocks with compact hornblende and a granular structure. Hornblende-gneiss (proper).
Locality. Between Laxford Bridge and Durness, Poolewe, Rona, Raasay, and many other localities.
(2) Rocks with hornblende occurring in fibrous or other aggregates :—
Locality. Between Scourie and Loch Inver, especially found in the same area as the augite-gneisses.
(3) Rocks with compact hornblende, and a more or less granulitic structure. Granulitic hornblende-gneiss.
Locality. In zones of secondary shear about Loch Inver.

IV. Rocks in which biotite is the dominating ferro-magnesian constituent. Felspar and quartz both present.
(1) Biotite occurring as independent plates or in aggregates of two or three large individuals. Biotite-gneiss (proper).
Locality. Between Laxford Bridge and Durness, Rona, Raasay, and many other localities.
(2) Biotite occurring in aggregates of numerous small individuals.
Locality. Associated with the augite-gneisses. A rare type.
(3) Biotite occurring as independent plates. Structure granulitic.
Locality. In zones of secondary shear.

While mapping the Lewisian gneiss of Raasay, Mr. Teall observed some curious patches of breccia in that island. One of these descends vertically into the Torridon sandstone, another occupies a similar position in the gneiss. The breccia consists of fragments of Torridon sandstone cemented with calcite, from which small rhombs of clear Iceland spar may be obtained. In one instance where the outlines of the breccia can be more distinctly traced, the ground plan of the mass is nearly semicircular, as if the breccia formed a plug in the Torridon sandstone.

Some interesting additions have recently been made to our knowledge of the Cambrian rocks of the north-west. Mr. Horne has found a band of fossiliferous ironstone, about two feet thick, in the "Fucoid beds" above Auchnashellach Station. The seam is full of a small discinoid or linguloid brachiopod. Mr. Macconochie has renewed his search for fossils in the *Olenellus*-zone, and has obtained additional specimens not only from the localities above Loch Maree and near Dundonnel, but from other outcrops of the same zone further to the north. He has detected fragments of trilobites together with other fossils of the same horizon on both sides of Loch Broom near Ullapool. He has likewise found them where the "Fucoid beds" appear in the River Achull, the Allatryne Burn, Strath Kaniard, Drumrunie and Knockan. Still further north Mr. Peach has obtained fragments of *Olenellus* from the same horizon at Inchnadamph. The ironstone-bed with brachiopods just referred to has been recognised by Mr. Macconochie in Glen Logan and other parts of

the Loch Maree district. It is thus shown that the "Fucoid beds" contain the fossils of the *Olenellus*-zone from the River Carron in Ross-shire to Loch Assynt in Sutherland.

An important addition to the evidence that tends to connect the quartzites and their associated strata of the south-western Highlands with those of Sutherland and Ross, has been obtained in the island of Islay. Reference was made in the last Report to the occurrence of worm-tracks in the dolomitic shales of that district which so greatly resemble the characteristic "Fucoid beds" of the north-west Highlands. Twenty specimens of tracks and burrows from the Islay shales have been obtained by Mr. Macconochie, and perhaps it is not too much to hope that eventually some of the other more distinctive fossils of the *Olenellus*-zone may yet be detected there.

In further prosecution of his mapping of the ground between Loch Carron and Loch Alsh, Mr. Peach has obtained additional confirmatory evidence of the view expressed in the last Report that the "Moine-schists" of that region are mainly altered Torridon sandstone and shale. These strata and their floor of Lewisian gneiss, which is occasionally brought up along sharp folds to the surface, are increasingly metamorphosed as they pass to the eastward.

Not less suggestive is the evidence recently obtained by Mr. Horne during his survey of the mountainous ground between the head of Loch Carron and Loch Maree. To the east of the great line of dislocation known as the Glen Logan or Kishorn thrust-plane, as in the ground south of Loch Carron, lenticles of Lewisian gneiss, brought up on the axes of isoclinal folds, occur among the Torridonian rocks, the whole series dipping in an easterly direction. That these long narrow exposures of gneiss are part of the actual floor on which the sedimentary formations rest, is proved by the occurrence of the basal Torridonian epidotic grits resting upon them. By means of this readily recognisable zone of grits and the shaly group that overlies them, it is not difficult to map out each separate isocline and to follow both the succession of the rocks and the structure of the ground.

As we advance eastwards, this metamorphism becomes more marked, the peculiar type or structure of the Moine or eastern schists coming out more and more clearly. It is difficult to understand that any other explanation of the sections can be adopted than that which obviously presents itself on the ground, namely that rocks having every character of true Moine schists, have here been produced by the alteration of a portion of the lowest Torridonian grits and shales with infolded cores of Lewisian gneiss.

Mr. Hinxman, working in that part of Strathspey which embraces the districts of Rothiemurchus, Abernethy and the ground between the Spey and the Dulnan, west from Aviemore, has met with a large tract of biotite-granite, similar to that of the Cairn-Gorm range, to which he proposes to give the name of Monadhliath granite, since it forms the eastern border of the Monadhliath mountains. He has ascertained that in this area, though the granite is fringed with abundant apophyses which penetrate the gneiss to distances varying from a few feet to 300 yards, no fine-grained edges indicative of the chilling of the intruded granite are to be seen. The injections of eruptive material have usually taken place along the planes of foliation, and the bands or planes of granite tend to branch out into mere strings. Besides the apophyses that can actually be traced into the main body of granite, many sills, bands or lenticular veins of similar material, may be seen in the gneiss immediately around the granite, and doubtless emanating from it. All the granitic bands, sills or veins, whether visibly proceeding from the granite mass or not, are thoroughly granitoid in texture and sometimes markedly pegmatitic. Not only do they present no chilled margins, but their crystals may be seen to interlock with those of the surrounding schists. Hence in this area there appears to be no reason to doubt that the present crystalline condition of the schists is coeval with the crystallisation of the material of the granite veins. The evidence, so far as it has at present been collected, appears to point to two conclusions. First, that the granites of Cairn-Gorm, Monadhliath, and other parts of Strathspey, together with most, if not all, of the sills and veins of granite and pegmatite in that region, belong to the same granitic protrusion and are derived from the same magma. Second, that this granitic magma has been protruded into a series of holocrystalline schists and quartzites, and that the contact metamorphism thereby superinduced, gave rise to the highly granulitic biotite-gneiss with bands of quartzite, which now forms the prevalent rock of the whole region.

In Deeside, Mr. Barrow has ascertained that the great granitic mass south of Banchory presents a very different character. The granite becomes rapidly finer in grain towards its margin, where it assumes the compact texture characteristic of a granite injected among already cooled rocks, while its apophyses are finer in grain than the main body of the rock. Of older date than this eruption is the granitic material, composed of microcline, quartz, and brown mica, which in a vast number of narrow dykes or veins traverses the highly crystalline schists of the south side of the Dee.

The age of the red sandstones which extend along the eastern shore of Arran from Corrie to Brodick and thence across the southern half of the island, underneath the various sheets of eruptive rocks, has been much discussed. By Sedgwick and Murchison these strata were classed as New Red Sandstone, a view that was subsequently adopted also by Ramsay. Afterwards, however, Bryce and other writers placed them in the Carboniferous system, and correlated them with the red sandstones of the north of Ayrshire and Renfrewshire. A re-examination of the ground was made last spring by the Director General in company with Mr. Peach and Mr. Gunn. They found that pebbles of the Carboniferous limestone with its characteristic fossils actually occur in the breccias at the base of these red sandstones between Corrie and the north end of Arran, as was first observed some years ago by Mr. James Thomson. Closer inspection of the coast-sections and of the interior showed that, besides this evidence of a decided stratigraphical break, the red sandstone, conglomerates and breccias lie unconformably on the Carboniferous formations, though at the actual junctions the two series seem almost conformable. That they are probably Permian may be inferred on two grounds. In the first place, the lower group of false-bedded brick-red sandstones presents the closest resemblance to the red sandstones which, within sight on the opposite mainland of Ayrshire, rest upon the Coal-measures, and have been referred to the Permian period. In like manner, they resemble the red sandstones of the south of Ayrshire, Wigtonshire, and Dumfries-shire, which are also assigned to the same period. In the second place, the Arran red sandstones have been found by Mr. Gunn to enclose a contemporaneous volcanic group, a feature which is specially characteristic of the Permian series of the centre of Ayrshire, and of Nithsdale. The occurrence of *Stigmaria* in the volcanic series which lies some hundreds of feet above the base of the red sandstones seems to remove these strata from the New Red Sandstone or Trias, while the strong lithological resemblance which, both as regards their sedimentary and volcanic components, they present to the Permian series of the mainland opposite, renders it highly probable that they are Permian.

Mr. Woodward has mapped separately in Skye, as he did in Raasay, the passage-beds between the Upper Lias and the Inferior Oolite, which include shaly layers, and bands and concretionary masses of calcareous sandstone. These strata in Raasay yielded *Ammonites variabilis;* while in Skye they have afforded a form identified by Messrs. Sharman and Newton as *Ammonites Siemensi*, indicative of the zone of *A. jurensis*. *A. Murchisonæ* occurs in the lower part of the Inferior Oolite, and many examples of *A. humphriesianus*, and other fossils, not yet determined, have been obtained from the fine cliffs between Bearreraig Bay and Invertote. The upper portion of the Inferior Oolite does not appear to be fossiliferous on this Skye coast. It contains some shaly, and lignitic bands, and concretionary masses of sandstone, differing to some extent from the mass of white sandstones so prominent on this platform in the eastern cliffs of Raasay.

The Tertiary dykes of Skye are now being mapped, both on the north-east and south-east coasts. In the latter area Mr. Clough finds them to vary petrographically between the two extremes of pitchstone on the one side and troctolite on the other. Those of acid or intermediate character on the coast north of Loch-na-Daal often indicate the direction of flow of the molten rock in the fissure, by the elongation of the amygdales and the orientation of the rows of spherulites. From the variation in the positions of these structural lines, it is clear that the movement of the lava was by no means always vertical, but was often approximately horizontal or oscillating between the two directions. Records of the variations observed are being kept by Mr. Clough.

III. *Ireland.*

In pursuance of the work described in the last two Reports, Messrs. Kilroe and McHenry have during the past year advanced over a large tract of the difficult ground between Clew Bay and a line drawn from Clifden to Oughterard. Evidence obtained by Mr. Kilroe leads to the conclusion that the Croagh Patrick quartzite and its equivalent further south does not belong to the "Dalradian" series, but is a part of the Llandovery formation. It will thus be necessary to colour as ordinary Silurian a considerable tract of ground which has hitherto been regarded as composed of metamorphosed rocks. The rocks have undergone a certain amount of metamorphism, but never enough to destroy the clear evidence of their original clastic character.

The investigation by Mr. McHenry of the tract of ground between Clifden and Oughterard has resulted in the collection of a body of evidence which seems to disprove the existence of any Archæan rocks, at least within the area examined. What have been supposed to be rocks of that early age are believed by Mr. McHenry to consist of a complex series of intrusive masses which have pierced the schists, limestones and quartzites of southern Connemara. His survey during last year in that region has convinced him that the whole of these rocks, igneous and sedimentary, are the equivalents in age and petrographical character of the eruptive and metamorphic (Dalradian) rocks of Mayo, Sligo, Leitrim, Donegal, and other parts of Ireland.

Early in March the Director General took the opportunity to make with Mr. Peach and Mr. McHenry an examination of some of the ground around Pomeroy in Tyrone, where there seemed reason to believe that evidence might be found of the occurrence of a marginal strip of Lower Silurian rocks like those which have now been found to flank the southern border of the Scottish Highlands. On a former occasion he had observed among these rocks a remarkable group of basic lavas and tuffs, but could see no evidence to warrant their separation from the chloritic schists to the north of them. Recent mapping along the borders of the Scottish Highlands, however, having shown that a similar group of rocks in that region could be recognised as probably of Lower Silurian age, it seemed desirable that the Tyrone district should be re-examined. The result has been so far highly satisfactory. In company with Mr. Peach, who has also visited the Scottish localities, the Director General spent some days in traversing the Tyrone sections, and had no difficulty in recognising the close similarity of the rocks there exposed to those along the Highland border. The igneous rocks form a strip of country about twenty-four miles long with a maximum of nine miles in breadth, lying between the Silurian and Old Red Sandstone rocks on the south, and the crystalline schists on the north. They include diabase and porphyrite lavas, tuffs, and intrusive sheets. The lavas are interleaved with cherts and jaspers exactly like those associated with the igneous rocks at the edge of the Highlands. Apparently overlying the volcanic masses come dark shales, which might yield graptolites, likewise pale grits and occasional thin limestones. In Scotland the cherts enclose *Radiolaria*, and though these organisms were not detected in any of the Tyrone sections on the occasion of this visit, it may be confidently anticipated that they will be found on further and more detailed search. The radiolarian cherts of the Highland border, with their lavas and tuffs, appear to be a prolongation of those which with the same characters lie in the Arenig formation of southern Scotland, where they extend over a wide area. The importance of the discovery of a zone of Arenig rocks along the edge of the schists in the Highlands and in the north of Ireland will be obvious to all those who have followed the discussion regarding the structure and age of these crystalline schists.

While engaged in the preparation of the "Handbook of the Survey Collections," Mr. Watts had occasion to make many critical examinations of the rocks in the cases of the Museum. Among the new facts which this investigation has established, the following may be noticed:—The wide extent of lamprophyres in the north of Ireland; the occurrence of perlitic cracks in the quartz of the Tardree rhyolite; the remarkable replacement of olivine by tremolite, which eventually develops into idiomorphic crystals in the picrite of Glendalough; the intergrowth of biotite and hornblende in the Crossdoney granite, and the contact metamorphism around that rock.

Among the pebbles in the Drift of the east of Ireland, pieces of a granophyre, with the mineral riebeckite, are not infrequent. Prof. Sollas has been fortunate in finding for the first time one of these pebbles which contains true crystals of the mineral. He has found them to possess well-developed faces, and has been able to measure and describe them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. W. B. Prowse, of Pembroke College, has been elected to the Burdett-Coutts Scholarship in Geology, and Mr. R. M. Brydone, of New College, was awarded the scholarship which was not given last year, tenable for one year only. The Burdett-Coutts Scholarship is of the annual value of £115, and is tenable for two years.

CAMBRIDGE.—On November 4 the two vacant fellowships at St. John's College were filled up by the election of Mr. F. F. Blackman and Mr. S. S. Hough, late scholars of the College. Mr. Blackman is Demonstrator of Botany in the University, and took a first class in both parts of the Natural Sciences Tripos. Mr. Hough is Isaac Newton Student in Astronomy, and was Third Wrangler and Smith's Prizeman. Both of the newly-elected Fellows have communicated important memoirs to the Royal Society. Mr. Blackman's researches on the respiration of plants were referred to with high commendation by Mr. Thiselton-Dyer in his presidential address to the Botanical Section of the British Association.

The choice of the electors to the Professorship of Botany, vacant by the death of Prof. Babington, fell upon Dr. Marshall Ward, F.R.S., late Fellow of Christ's College, Professor of Botany at the Royal Engineering College, Cooper's Hill. Prof. Marshall Ward graduated B.A. in 1879, taking a first class in the Natural Sciences Tripos.

The State Medicine Syndicate report that, in view of the increasing importance of the study of bacteriology in relation to public health, they have decided to extend the time given to the subject in the Sanitary Science Examination, and to appoint a fifth Examiner specially conversant with it. Thirty-one candidates received the Diploma in Public Health in the last academic year.

The skeleton of a Chillingham bull has been presented to the Museum of Zoology by the Earl of Tankerville.

THE Report of the Royal Commission on Secondary Education has at last been published. The Commission was appointed in March 1894, "to consider what are the best methods of establishing a well-organised system of Secondary Education in England, taking into account existing deficiencies, and having regard to such local sources of revenue from endowment or otherwise as are available or may be made available for this purpose, and to make recommendations accordingly." The Report is divided into four parts, referring respectively to (1) previous legislation on the subject; (2) the state of things now actually existing; (3) the evidence submitted to the Commissioners, with a discussion of the views and suggestions of certain leading witnesses; (4) recommendations calculated to bring about that correlation of existing agencies and economical application of existing funds, which are required for the proper organisation of Secondary Education. Technical Education is included in the term Secondary, and the suggestions in the Report refer to both alike.

DR. FRANZ KÖNIG, Professor of Surgery in Göttingen University, has been elected successor to the late Prof. von Bardeleben in the Chair of Surgery at Berlin. Dr. Joseph Disse, of Halle, has been appointed Professor of Anatomy at Marburg. Mr. Frank H. Constant goes to Minnesota University as Assistant-Professor of Structural Engineering, and Mr. H. Wade Hibbard as Assistant-Professor of Machine Design. Dr. Partheil, of Marburg, has been appointed Professor of Pharmaceutical Chemistry at Bonn.

A FREE library, comprising museum, art galleries, and four branch libraries, has just been opened at Pittsburg. The erection of the institution has taken three years, and the cost—£200,000—has been defrayed by Mr. Andrew Carnegie.

MR. CECIL SMITH has gone to Athens to take up the Directorship of the British School there.

SCIENTIFIC SERIALS.

American Journal of Science, October.—Recent progress in optics, by W. Le Conte Stevens. This paper was read before the American Association, and gives an admirable summary of Michelson's work with the interferential comparer, of Wiener's experiments with stationary light waves, of recent researches on luminescence, and other subjects.—The quantitative determination of perchlorates, by D. A. Kreider. The method is essentially the collection of the oxygen of the perchlorate; its subsequent passage into an atmosphere of nitric oxide over a strong solution of hydriodic acid, and the titration of the iodine thus liberated with decinormal arsenic in alkaline solution. The apparatus employed consisted of a piece of combustion tubing, 10 or 12 cm. in length, drawn out at one end and connected with a receiver filled with caustic potash. A platinum boat carried the perchlorate, which was covered with a mixture of sodium and potassium carbonates. The tube was then filled with carbonic acid, and then the oxygen was evolved by fusion. The oxygen was swept by a current of CO_2 into a receiver consisting of two levelling bottles. For the action of the oxygen on hydriodic acid through the medium of nitric oxide, a bulb pipette was used with stopcocks at both ends. This was filled with a known amount of hydriodic acid, and the air expelled by CO_2, after which it was exhausted and a small quantity of nitric oxide was admitted. Then the oxygen was allowed to enter slowly under the diminished pressure, while the bulb was constantly shaken. It was then removed for titration.—Demonstration of caustics, by R. W. Wood. A strip of thin polished steel is bent into an arc formed by pins stuck on a board. A piece of cardboard is placed across the opening of the arc, and slits are cut in it about half an inch apart. A piece of photographic sensitive paper is stuck on a board inside the arc. On directing the apparatus towards the sun, parallel rays are traced from the slits to the mirror, and also their reflections, and the latter form the caustic surface appropriate to the curvature of the mirror.—The law of electromagnetic flux, by M. I. Pupin. The author endeavours to show the exact position which this law occupies in Maxwell's electromagnetic theory; to point out its limitations; to show that Maxwell's electromagnetic theory of light demands a more general form of this law; and to present a general form of this law of which the forms given up to the present are special cases.

American Meteorological Journal, October.—Fog signals and meteorology, by Prof. H. Hazen. The author discusses the penetrating power of various signals, the conditions under which fog is formed, and the effects of the winds and topography upon the audibiity of the signals. He considers that, apart from the facts that a sound can be heard about twice as far with the wind as against it, and can be heard farther from an elevation than at the level of the sea, there is hardly a point which is well established. Also that the evidence points very strongly against the use of sirens or trumpets in any but a few exceptional cases where a very long range is demanded. A perplexing difficulty, referred to by the late Prof. Henry, arises from the fact that the signal often seems to be surrounded by a belt, varying in width from one to one and a half miles, from which the sound appears to be entirely absent. He considers that there is urgent need for a series of experiments from a rock or very low island, with open water for ten miles on all sides. Such experiments would probably elucidate many of the perplexing phenomena which now exist.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 16.—Prof. Meldola, F.R.S., President, in the chair.—The President announced the deaths of Prof. C. C. Babington, F.R.S., the last but one of the original members of the Society, and Prof. C. V. Riley, one of the ten Honorary Fellows of the Society, and commented upon their scientific work. Mr. W. F. H. Blandford spoke at some length on the valuable services rendered by the late Prof. Riley to the cause of economic entomology, and referred to the enormous number of papers and memoirs on the subject which he had contributed. Lord Walsingham, F.R.S., also spoke as to the importance of the late Prof. Riley's work and the respect and regard which he felt for his estimable personal qualities.—Mr. F. C. Adams exhibited a series of nineteen *Merodon equestris*, containing several varieties, showing their resemblance to wild bees of the family Apidæ, and made a few remarks on mimicry. He also exhibited specimens of *Leptomorphus walkeri*, Curt., taken in the New Forest in September last, and *Melanostoma hyalinatum*, Fln. (male and female), also taken in the New Forest in the latter part of August last. Mr. Verrall, Dr. Sharp, F.R.S., and Colonel Yerbury made some remarks on the species and their distribution.—Mr Enock exhibited, and made remarks on, specimens of the mature male and female, and the nest of *Atypus piceus*, the British Trap-door spider; also male and female specimens of *Andræna atriceps* and males of *A. fulva*.—Mr. Tutt exhibited a long series of 143 males and 25 females of *Erebia nerine*, captured in the Tyrol, partly in the Mendel Pass and partly in the Val d'Ampezza, and read notes on the species, in which he criticised the description of it, and the published observations as to its habits, by Dr. Lang, Mr. Elwes, and others. Mr. Elwes made some remarks in reply.—Lord Walsingham exhibited the type of *Pseudodoxia limulus* (Rghfr.), together with the larval cases and a preserved larva. He directed attention to the curious truncate concave head of the larva which forms an operculum to the tube, and remarked that the cases of this insect, which were apparently not uncommon in Ceylon, the larva feeding on mosses and lichens, had been known for some considerable time. So long ago as 1864, Mr. McLachlan found them in the British Museum collection of cases of caddis worms, and at that time, being only acquainted with the case, he was disposed to consider them the work of one of the *Leptoceridæ*. In 1889, Herr Rogenhofer gave the name *Fumea (?) limulus* to the case and its contents, and Mr. McLachlan agreed from the evidence then adduced that the insect was *Lepidopterous* rather than *Trichopterous*.—Mr. C. J. Gahan exhibited, for Mr. Turner, an imago and some larval forms of *Ledra aurita*, Linn.—Mr. G. C. Griffiths exhibited, and read notes on, hybrids between *Platysamia cecropia* (male) and *P. gloveri* (female), and between *P. cecropia* (male) and *P. ceanotha* (female); also between *Actias luna* (male) and *A. selene* (female). He stated that these hybrids were bred by Miss Emily L. Morton, of New Windsor, New York, in 1891, 1892 and 1893.—Lord Walsingham stated that at the last meeting of the Society some discussion ensued, after the reading of his paper, in consequence of his having alleged that *Grapholitha*, W., was preoccupied by *Grapholitha*, Hb. (Verz. Schm.), and he read a supplementary note on the subject explaining the references in his paper.—Dr. A. G. Butler communicated a paper, entitled "Notes on seasonal dimorphism in certain African butterflies."

PARIS.

Academy of Sciences, October 28.—M. Marey in the chair.—The Associates and Correspondents of the Academy are invited to send their photographic portraits to the Secrétariat to form part of a projected album.—Lord Kelvin read an address from the Royal Society of London, and then expressed his appreciation of the honour conferred upon him by his election as a Foreign Associate of the Academy. In his speech he referred to France as his *Alma mater* in science, and mentioned his personal connection with Regnault in 1854 at the Collège de France.—On the multiple roots of algebraical equations, by M. Brioschi.—On the differences of longitude between Nice, Ajaccio, and Rousse Island, by MM. Hatt, Driencourt, and Perrotin. A telegraphic determination in which observations have been carried out between different pairs of observers, and checked by comparing the longitude of Ile Rousse determined from Nice with the longitude of the same place determined from Ajaccio, which itself had its longitude compared directly with that of Nice. The direct determination of the difference in longitude of Ile Rousse and Nice gave 6m. 34·45s. ± 0·01s. Indirect determinations gave 6m. 34·442s. ± 0·019s., and 6m. 34·465s. ± 0·017s.—M. Armand Gautier presented the second volume of the second edition of his "Cours de Chimie," and described the points in which it differed from the first edition.—General A. de Tillo presented and described a relief map of the western part of Russia, and the bordering parts of contiguous States.—On chemical equivalents, by M. Marqfoy. The author enunciates the following as a law of chemistry, and supports it by tables printed in the abstract: "The actual equivalents of chemistry are the prime numbers comprised in the natural series of whole numbers from 1 to 300." He adds that he has established the constitutive theory of substances based on the unity of matter. He introduces *porosity* into the consideration of volumes, and asserts that he thus overthrows Dulong and Petit's law, and Avogadro's hypothesis. The author has found the following

law to hold: "The specific heat multiplied by the density equals the porosity, the porosity of hydrogen at the given temperature and pressure being taken as unity."—Observations of the comet 1895, August 20, and of Wolf's planet (1895, October 13) made at Toulouse observatory with the great telescope, and the 0·25 m. equatorial, by M. Rossard.—On the double diurnal oscillation of relative humidity, by M. Alfred Angot. It is shown that the phenomena described by M. Éginitis in a recent number of the *Comptes rendus*, is due to sea-breezes, and has been noticed previously. It does not occur in continental stations, on plains or plateaux.—Observation of an electric phenomenon, by M. Mettetal. A description of an electric fire-ball observed in stormy weather, but in the absence of thunder and lightning, at Grenoble, on October 2. The phenomenon vanished without detonation.—Researches on lithium, magnesium, and cuprous cyanides, by M. Raoul Varet. A thermochemical paper giving the heats of formation of these cyanides. It is pointed out that there is not the same parallelism between the cuprous and cupric cyanides as obtains with the mercurous and mercuric salts.—On beryllium carbide, by M. Louis Henry. The author calls attention to the weakness of M. Lebeau's argument for assigning the atomic weight 14 to beryllium, and recapitulates the considerations which have determined the acceptance of 9 as its atomic weight by most chemists.—On the analysis of emerald, by M. P. Lebeau.—On the estimation of argon, by M. Th. Schlœsing, jun. The author discusses the errors inherent in the method lately described by him, and gives results of the estimation of argon in air taken at different times and from different places. The amount found is constant at 0·934 per cent. Gases from soil show some variations in the amount of contained argon, possibly due to the solubility of this gas.—Synthetical formation of a new ketonic acid, by M. E. Burker.—On the muscles of ants, wasps, and bees, by M. Charles Janet.—On the development of nerve terminations (neuromuscular junctions and motor plates) in striated muscular fibres, by MM. G. Weiss and A. Dutil.—Liquefaction of gelatine, saline digestion of gelatine, by MM. A. Dastre and N. Floresco.—Researches on the biological value of inflammatory leucocytosis, by M. Wladimir Woronine. Localised inflammatory leucocytosis is peculiar to vertebrates, and is an accidental consequence of the particular conditions occurring in their system of blood circulation. Leucocytosis is not a purposed defence against an enemy which has penetrated the organism, as the phagocyte theory maintains. The modifications which are common to all the cases studied are not aggressive, but passive.

DIARY OF SOCIETIES.

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THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On Mimicry in Butterflies of the Genus Hypolimnas, Hübn.: Colonel Swinhoe.—A Revision of the Genus Pentas, Benth.: G. F. Scott Elliot.—An Account of the Butterflies of the Genus Charaxes, Ochs.: Dr. A. G. Butler.

CHEMICAL SOCIETY, at 8.—The Temperatures of Flames and the Acetylene Theory of Luminosity: Prof. Smithells.—The Action of Acidic Oxides on Salts of Hydroxy-acids: Prof. G. G. Henderson and D. Prentice.—Sodium Nitrosulphate and the Constitution of Nitrosulphates: Profs. Divers and Haga.—And other Papers.

FRIDAY, NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—The Magnetic Field of any Cylindrical Coil or Plane Circuit: W. H. Everett.—The Latent Heat of Volatilisation of Benzene: Mr. Griffiths and Miss Marshall.—The Comparison of Latent Heats of Volatilisation: Prof. Ramsay and Miss Marshall.

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